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Special Planing Jobs.

The planer and the shaper may be used in a great many different ways and for very different purposes. Among other things the planer table may be used for an anvil, in which case the first man who tries to do a job of planing on the maltreated machine will do well to look about him a bit.

A 6-foot planer in a reaper shop had been used for an anvil for riveting and straightening sickle bars. The sickle-bar job, which involved a good deal of hammering on each one of eight or ten thousand of those articles, was done, and I took the machine to do something considerable in the way of a job which wanted to be planed as well as possible. The foreman said he didn't think the planer was in very good order, as it had been standing still for several months. I told him I could make flat work and true work on any planer that would run, so the foreman walked away with a grin as I proceeded to dig the planer out of the dirt, lace the belts on, bore out the oil-holes with a breast drill—the shop used oil that was "just as good as lard oil and a good deal cheaper," and which had a way of filling oil-holes with solid plugs of cement that nothing short of a twist drill would remove—and along about noon I had the table running and the saddle so I could move it on the cross-rail. After dinner I filed the big lumps off the table and put a fine point tool in the tool post, tried the table and found it over a quarter of an inch crowning in the length of the bed, and a sixteenth or so higher on two of the corners than on the other two. I showed the foreman how it was, and after some talk he consented to have the table planed up. My first thought was to put in a diamond point and take that ¼-inch crown off all at one cut. After I had the tool in, I took hold of the belt and noticed the big gear had a lot of play in the rack-teeth, and that made me take a look along the face and side of the rack under the table, and I saw that was humped up in the middle too, same as the table was on top. If the table had not been standing about the middle of its travel, so that the rack stood ¼ inch high over the gear and made it so loose that I noticed it the first pull I gave on the belt, I should have taken all that ¼-inch crown off the top of the table at the first cut, but seeing the rack so high in the middle I began to think, and made up my mind that about 3-32-inch was more like what I wanted, so I started with that depth of cut, having first leveled up the cross-rail as near to the grand average of the humped table as I could guess. The 3-32-inch depth of cut touched the table for about two or three feet in the middle when I first started, and as the cut proceeded, the table began to drop down, and I followed it down with the tool, so that the cut grew longer and longer as it worked across the bed, and finally touched all the way but about 6 inches at each end when the cut was all the way across, and when I shoved the saddle over to the back edge where I started first, I found the tool as it stood for the first cut would touch each end of the table and was clear in the middle by about a thirty-second. I leveled up the cross-rail again, and ran the same cut across once more. I tried the cross-rail again, and found it stood about right with the table, and then took a heavy flat tool cut that just touched the two high corners, which were only a very little high at that stage of proceedings. I then took a light scrape, which did not reach the bottom of my first cut where it started, however. But a couple more scraping cuts put the table all flat and in nice shape, and no one but myself ever knew that my first cut of 3-32 inch was too deep for a planer table crowning a full quarter inch.

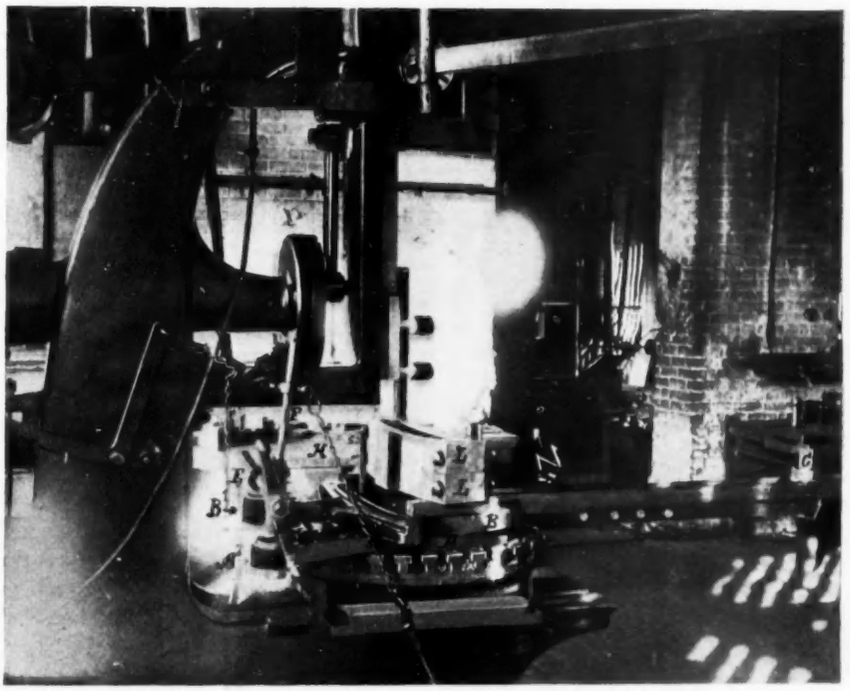

Fig. 1. LINK SLOTTER, ROGERS LOCOMOTIVE WORKS.

A planer table always wears crowning, higher in the middle of its length, because driving pins and stakes in the holes in the table always stretches the top, unless the stake holes are quite deeply countersunk, as they commonly are made now in late practice. That was not the way things were done at first. The "pening" of a planer table, which makes it crown, is always greatest in the middle of the table, and if a table is very much out, the correct thing is to start a small cut and run it three of four inches on one side of the

middle groove, and then pull the tool over and take the same cut the same distance on the other side of the middle groove, not starting on the back edge of the table and going all the way over to the front. After this strip in the middle of the table has a cut over it, set a tool in the tool post and try the four corners of the table and the middle, and take a cut all the way across, and be sure not to take too much

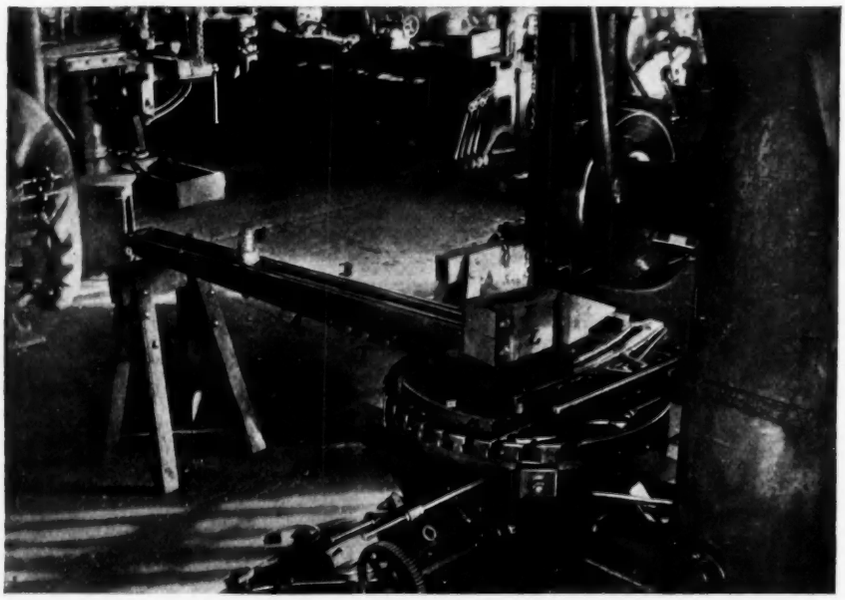

Fig. 2. LINK SLOTTER, ROGERS LOCOMOTIVE WORKS.

the first time. If I had taken that full quarter off the sickle-shop planer table at the first cut on the back edge, the tool would have just touched the whole length when it worked across to the front edge of the table, and I would have had to take a cut a quarter inch deep off the ends to reach the scoop cut in the middle on the back side where I started the cut, which would have been good-bye to the old table, because there was hardly enough metal left over the T-grooves to swear by as it was.

Up to within a short time, some of our leading makers located both the bevel pinions on the inside of the bevel gears which drive the cross-rail elevating screws, thus necessitating one right-hand and one left-hand screw. This was done solely with the New England idea of making things "look right," which accounts for most of the absurd crooks in American machine-tool design to-day. Every lathesman knows that it is very difficult to cut a right-hand screw and a left-hand screw that will "match up" with each other, and the consequence was that these planers with right and left screws could never be depended upon to keep the cut parallel with the table-top. Several of these machines were put on one job where the utmost nicety of planing was demanded, and the cross-rails were locked fast to the uprights and never allowed to be raised or lowered, special fixtures being built to bring the work to the right hight. The gear of these planers was changed to make both screws right-hand, long ago, but they should never have been made right and left, and I do not think many planers now built have right and left cross-rail elevating screws.

It is extremely annoying to have work come off a planer thicker on one edge than the other, crosswise. In such a case the first thing is to see that the elevating screws are straight. If they are, and one is right and the other left hand, then make a pair of new screws, cut in the same place on the same lathe, and change one gear stand on the top girt so as to run both screws the same way. If the shop will not permit so much machine work, then take time with all jobs that have to be turned over and planed on both sides, to try the cross-rail with a surface gage on the table with the needle against the under edge of the cross-rail dovetail, and paper up on top of the low cross-rail hook until the rail comes right by the surface gage.

A Baldwin Locomotive Works planer was shown in this paper in which the tool slide was connected to a radius link, thus enabling the machine to produce trough-shaped surfaces. Fig. 1 shows a variable radius fixture used in the Rogers Locomotive Works, Paterson, N. J., for slotting locomotive links inside to a true arc, and Fig. 2 is another view of the same tool. *A* is the sole plate of the fixture bolted to the slotter table, which remains stationary while this link fixture is in use. This sole plate has, extending in front, a long radius arm. *B* the swinging part of the fixture on which links in process of shaping are clamped, is jointed to *A* at *C*, with such a joint as is used in proportional dividers, which can be adjusted to any radius required. The outer end of the radius arm is supported by a wooden horse, evidently made for the purpose. A fracture seems to have been repaired by the four bolts and two side plates at *I*. On top of the top member *B* of this fixture, a pair of links *L L* are seen supported on parallels, to give the slotting tool room to pass down. The clamps and bolts were removed to make a clearer picture of the principal parts. To give

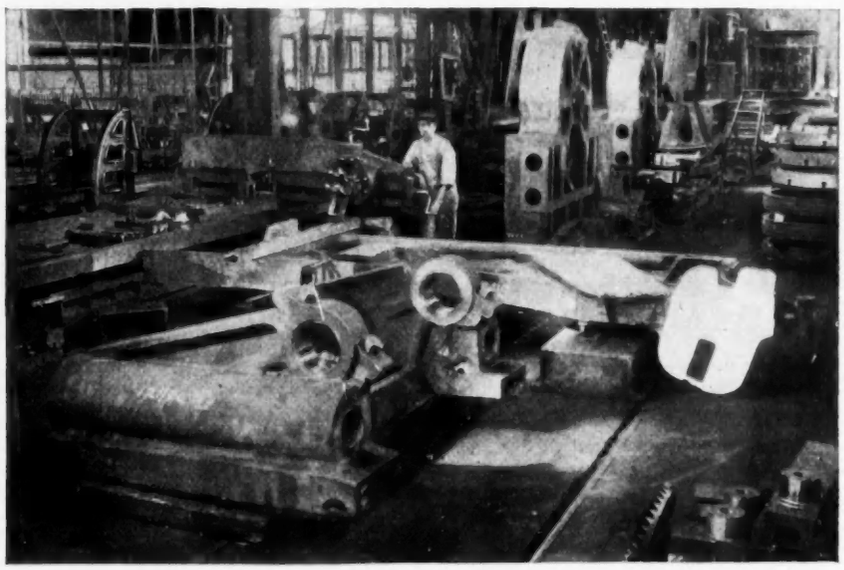

Fig. 3. PLANING WORK ON THE FLOOR, POND SHOPS, PLAINFIELD, N. J.

this swinging top member *B* a suitable feed, the screw *E*, Fig. 1, is journaled in a stud, which stud swivels in the socket A^1, which is in a hub at the outer end of a short arm forming part of the sole plate *A*. In front of the swivel stud in which the screw is journaled is seen the double-ended hand crank *D*, by which the feed screw is turned. Close back of *E* is a ratchet-brace power feed, having

its handle *F* reaching upward. This handle carries a two-eyed clip fitted to slide and be secured on the handle at any desired point. From one clip-eye a chain leads to the bell-crank arm *G*, which is reciprocated from a moving part of the slotter. The right-hand eye of the ratchet-handle clip takes the upper end of a second chain leading down to a spring rod, as clearly shown, so that the spring will pull the ratchet arm one way, and the bell crank *G* will pull it the other way. The feed screw *E* takes into a nut swiveled in

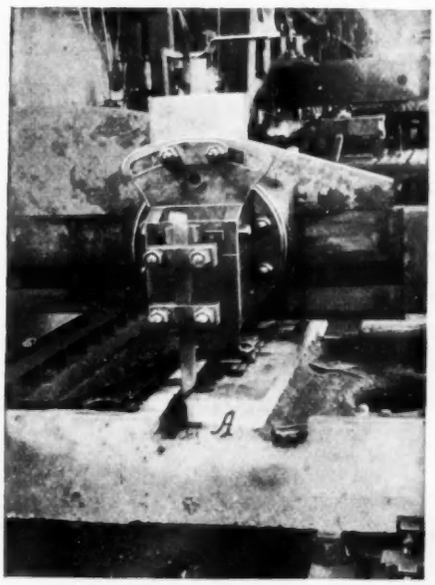

Fig. 4. PLANING AN UNDERCUT. SPECIAL TOOL LIFTER. POND SHOPS.

the end of arm B^1, projecting from the inner end of the swinging part of the fixture *B*. As both the nut-stud and the screw-stud are swiveled, and the ratchet arm *F* is chain-driven, the feed screw can swing and feed *B* in the arc of a circle whose radius is defined by the position of the stud *C*. This is a simple and cheap rig, and as it has been in use many years and is considered entirely satisfactory at the Rogers Works, it is worthy of consideration. It is the cheapest link-shaping rig I have seen.

Fig. 3 is a view in the well-known Pond shops, Plainfield, N. J., which were doing some very heavy work on gun carriages at the time this picture was taken, the pieces being beyond the capacity of even the largest of the very large planers in that finely equipped establishment. Consequently, this work was leveled up on the floor, and a heavy special cross-rail, carrying a tool holder, was bolted to the planer table, and the still piece was finished with the moving tool, "side planer" style, instead of in the usual way of planing.

On this job was a square undercut, plainly shown at *A*, Fig. 4, requiring the tool to be lifted and carried back over the work by some device, also arranged to drop the tool into working position as soon as it travels far enough back of the work to permit. Fig. 5 is a side view of this lifter with the tool in cut, same position as shown in front view in Fig. 4.

It is customary in making undercuts to wedge the clapper so it cannot turn on its pin and so keep the tool always down, or to carry it back by hand, which in the case of a large planer is very hard work, and would be next to impossible in this case, as the man would have to scramble along the top of the work, holding up the heavy clapper as best he could.

Of course, if anything in the automatic way is used to lift the tool, it must be something reliable, because if it fails to work as expected, it will either lift the work or break off the tool on the back stroke. Sometimes both these undesirable events happen.

A thoroughly convenient and reliable tool lifter is therefore of great importance, and this one at the Pond shops is the best for the purpose within my knowl-

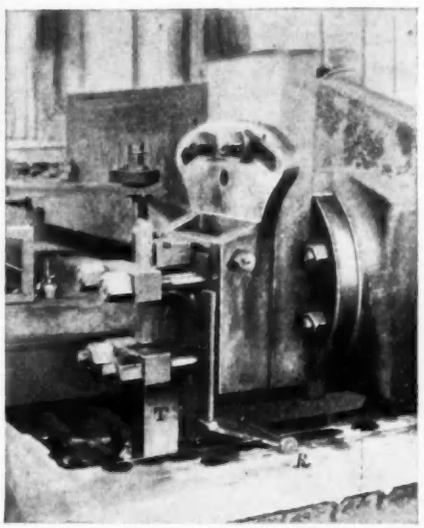

Fig. 5. PLANER TOOL LIFTER, POND SHOPS.

edge. It consists of two pieces of sheet metal of about equal dimensions, hinged together. The upper one, *A*, Figs. 5 and 6, is hinged at A^1 to *B*, the lower member, and *B* is provided at its lower corners with rollers R, on which the hinged piece is carried in both directions of travel. The upper member *A* is slotted to pass over the tool-post studs, and is held in place by having the tool screwed down on it when in use. Such a heavy clapper and tool as are shown would drop too hard in the saddle if allowed to fall directly when the roller *R*, Fig. 5, runs off the work surface, and the buffer frame D^1DD, made of pine scantling, is fastened to the floor to catch the tool as it falls. The severity of the blow thus averted is evidenced by the battered condition of this top bar D^1, Fig. 6.

Let no one imagine for a moment that these detail devices are beneath the attention of high-grade engineers. The principal difference between the good shop and the bad shop is to be found in minor facilities, which both expedite work and preserve the machine tools. The bad shop is managed on the principle of doing the best you can, while the good shop believes in having the best you can to do with, and there is a big difference between the two schemes. Where all the little things are looked after in good season, the big things seldom give much trouble.

JOHN RANDOL.

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The Lawyer and the Engineer.

We take the following from an unusually thoughtful and suggestive paper by W. F. Goodhue, in the "Proceedings of the Purdue Society of Civil Engineering" for 1896:

"I have become impressed with numerous facts which affect all branches of the profession and I will begin by stating two of them. One is the strong and tenacious grasp with which the lawyer holds his position in connection with important engineering work and manufactures. The second is the weak and ephemeral grasp with which the engineer holds his position on the same work. We will say, as is commonly the case, that both are employed about the same time and for the same reason, fitness and ability in their respective fields of labor. Invariably the lawyer receives the larger salary at the start. As the work progresses the lawyer always strengthens his hold upon his posi-

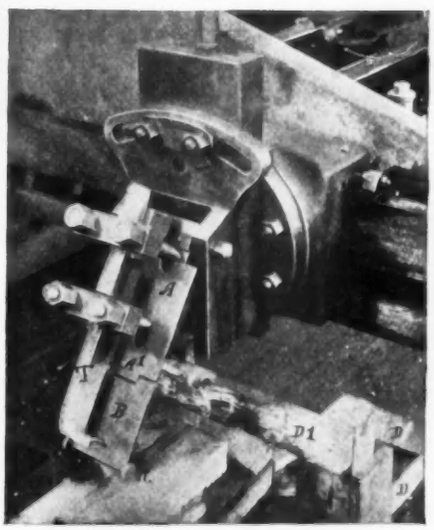

Fig. 6. BACK TRAVEL "POND" LIFTER HOLDING TOOL UP.

tion, while the engineer's hold seems to grow weaker, and when the work is done he usually disappears from sight, to be heard of later, engaged elsewhere upon other work. But the lawyer remains upon the work after its completion and oftentimes becomes its manager; he soon becomes rich and influential and upon occasions he will represent the power and standing of the concern employing him. The engineer as a rule works harder, both mentally and physically, than the lawyer does; he receives a fair compensation for

his services, nothing more, and seems to be at all times outside of and never a part of the business management and responsibility of the concern he serves so well and faithfully.

* * * * * *

"The lawyer when employed knew nothing of engineering, and afterward learned nothing of it, only in a general way, and the engineer knew nothing of law, nor were there such pretensions made in either case. Perhaps the lawyer was better trained outside of his profession than was the engineer outside of his. If this answers the question, then there is something radically defective in the training of the engineer and much to commend in the training of the lawyer. Then this answer will also explain why so many of our largest manufactories and engineering works, railways, etc., are to-day controlled by men who are educated lawyers, and who know absolutely nothing of the details and manipulations of the business they control.

"About twenty years ago a railway in Illinois became insolvent, and a receiver was appointed to take charge of its affairs. To reduce expenses the receiver began by reducing the number of employés, and the first to go, as usual in such cases, was the engineer and all his tribe. For a number of years the road was operated in a cheap, haphazard sort of a way, when it was sold to an Eastern syndicate, who took immediate steps at reorganization, and I was appointed engineer in charge to rebuild the road. My first work was to thoroughly inspect the entire property and determine what was immediately necessary to make it safe for traffic and also remunerative. I found that the roadbed, bridges, buildings, etc., had deteriorated beyond redemption, that the whole line must be rebuilt. At this time the road had been for about five years in the hands of a receiver, a lawyer. I labored hard and faithfully for six years, putting the entire road and its branches into first-class condition, and under its excellent management it has so remained to this day. For my services I received about $12,000. The lawyer remained with the road some years longer than I did, and when it passed out of the hands of the master in chancery, by which act the office of receiver was abolished, the court ordered that the lawyer be paid from the proceeds of the sale of the road the sum of $125,000.

"Now I do not cite this as a disparagement to lawyers, but as an example of the generally recognized value of a lawyer's services, and it also demonstrates the tenacious grasp with which a lawyer holds upon all properties which he is called upon to control and manage.

"The railway property deteriorated under his management. He placed few betterments upon it. Had he employed a competent engineer much of the deterioration could have been prevented and expensive repairs avoided; besides the traffic would have been heavier and the earnings thereby increased. There were many engineers in the country (most of them out of employment at that time, for it was shortly after the great panic of 1873) who were thoroughly competent to handle the property in a very economical and remunerative manner, making it far more valuable than it proved to be when sold to the Eastern syndicate, and none of them, had they the position offered them, would have refused it at a salary of $2,500 annually. Yet, for all this, the lawyer was paid ten times more than was the engineer who repaired his wasteful management.

"I see no reason why the engineer should not hold positions of equal responsibility and value with the lawyer. Lawyers hold these positions without becoming engineers; then why should not engineers attain them without becoming lawyers? If both are liberally and broadly educated their chances should be equal. I do not consider the question of natural ability at all. Bright men are not possessed exclusively by any one vocation of this busy world."

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Concerning Gages.

Wooden gages may be divided into two classes, "easy-running" and "hard-runnig" gages, and while the cause of the "hard-running" is usually obvious, there are few who have applied a remedy.

If the staff is not rigid in the head, the gage belongs to the "hard-running" class, in which the marker alternately "sticks" and advances, describing short arcs of circles as it moves along the board. Since rigidity is all-important, why do all manufacturers insist on trying to secure it by jamming one flat surface against another, as shown in Fig. 1? Since the forces exerted all act in the plane of the arrows, why not hold the staff rigid against the action of such forces, by placing the binding screw as shown in Fig. 2, or by using a wedge as shown in Fig. 3?

Fig. 1
THE COMMON GAGE.

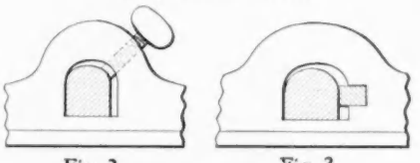

Fig. 2 Fig. 3
BETTER FORMS.

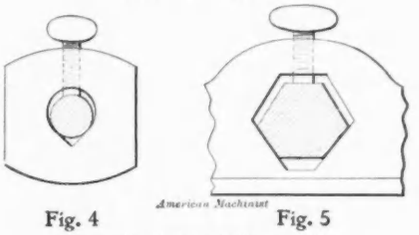

Fig. 4 Fig. 5
OTHER IMPROVED FORMS.

A few years ago the writer had the "inventing fever" and produced a gage like this (Fig. 4), a round staff held down into a V by the binding screw. This form is both rigid and easy to adjust, and is especially neat for thumb gages.

Fig. 5 shows another form of the same idea. If now the marker is made of a thin piece of metal, of the form shown in Fig. 6, and if it is held in place by a heavy screw, preferably a machine screw working into a metal cap at the end, the result is a marker with no tendency to stick, and which leaves a straight row of fine dots, regardless of the grain of the wood. This is especially nice for *end* wood; or if the adjusting screw at the end is set up tighter, the marker will not turn, but will act as an ordinary marker, with the advantage of new points available as the old ones become blunt.

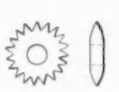

Fig. 6
MARKER.

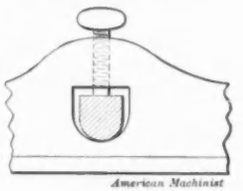

Fig. 7
A LITTLE IMPROVEMENT.

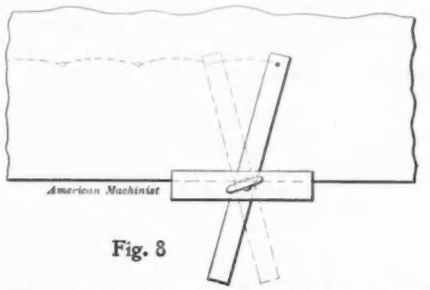

Fig. 8
THE CROSS BETWEEN THE GAGE AND A PAIR OF SHEARS.

Having invented what is believed to be a "good thing," the writer set out to dispose of his invention—and this is another story. It will not be inappropriate to add, however, that this selling process is an excellent cure for the "inventing fever."

There may be some special virtue in the form of cross-section of the staff shown in Fig. 1, which is the form commonly adopted by manufacturers of panel gages. If this is the case, then it is a pity that the position of the staff in the head cannot be changed, giving the form shown in Fig. 7, which would certainly be an improvement over the usual type, which a witty mechanic, referring to the relative motion between the staff and head, has fitly described as "a cross between a gage and a pair of shears."

A panel gage is not a very important tool; but this is scarcely an excuse for disregarding in its design the principles of mechanics and the promptings of common sense.

An Automatic Feed Stop for Planers.

An automatic feed stop for a planer, and, indeed, often also for a lathe or other self-acting tool, is not a bad thing to have. Many a job has been hopelessly spoiled that might have come out all right if such a device had been in existence. There are many places also where a man's attention might be otherwise profitably employed if the machine could be de-

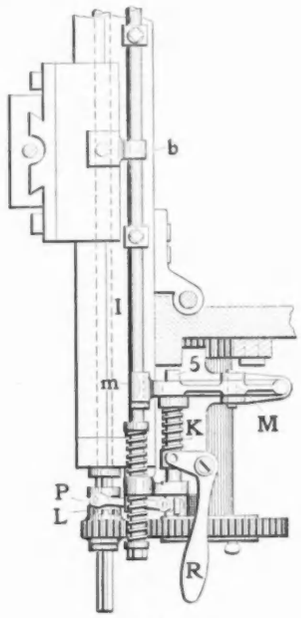

Fig. 1

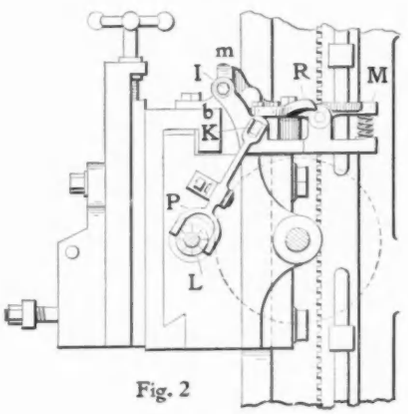

Fig. 2

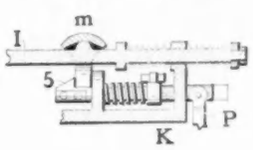

Fig. 3

AUTOMATIC FEED STOP FOR PLANERS.

pended on to stop its work before going too far.

The sketches herewith show a recently patented arrangement for this service. It is, as will be seen, arranged to operate the same, whether the tool carrier is feeding to the right or to the left. Referring to Fig. 1, which is a top view of a planer cross-rail and appurtenances, the sliding rod *I* will be noticed, which moves freely in supporting brackets at each end of the rail. This rod is held in a normally central position by two springs, one on each side of the right-hand supporting bracket. Two adjustable collars upon this rod are placed to be struck by the projecting tappet *b* on the back of the tool-carrying hand when it has reached the determined point in either direction. The rod has upon it a lug 9, Fig. 3, which, when the rod moves in either direction, lifts the end *m* of the lever *M*, releasing the hook 5, which allows the rod *K* to move, this rod operating the short lever *P* and throwing out the clutch *L* on the feed screw. The hand lever *R* throws in the clutch and allows the end *m* of the lever *M* to drop again over the hook 5 until again automatically released.

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Working and Hardening Steel.

"Nearly all persons, in writing on the proper method of working steel, lay too much stress on over-heating, or what they term 'burning steel.' During my experience, I have found that there are more steel tools destroyed by working too cold, or improperly manipulating on the anvil, than from any other cause. The uninitiated have heard so much about burning steel that they are really afraid to bring a piece of steel to the proper heat for forging purposes. I have often seen the novice working steel down to a black heat under the steam hammer, not only destroying the structure of the steel, but the hammer dies also.

"A man working at the fire next to mine continually had complaints coming to him about his tools being burnt; in fact his tools would come back broken off about ½ inch from the point, showing a coarse black structure, similar to a piece of over-heated or disintegrated steel. The poor fellow was hammering away on cold steel all day long. Finally he said to me, 'Why is it that they all tell me that my tools are all burnt, when I work them at a much lower heat than you do; yours do not break short, mine do.' I told him that his tools were not burnt, but improperly manipulated on the anvil; i. e., worked too cold, and not properly hardened after being brought to the proper shape. He replied, 'If I were to bring steel to the same heat you do, they would all break off about ¾ inch from the point.' He then showed me many of his tools broken off as described. I examined the tools which were not broken, and which had given good service after the last dressing, and found that nearly all of them had been reinforced about ¾ inch back from the point; this compression is almost imperceptible to the naked eye, but can easily be felt by passing this part of the tool between the thumb and finger. I informed him that the next time he dressed these tools they would break at the point mentioned as soon as put in service, and show a dark, coarse structure, similar to over-heated steel; the men using the tools would upbraid him for burning the tools.

"The cause of so many tools breaking at this point is improper hardening, or rather, the hardening and tempering are done too quickly, leaving a hard and soft section in conjunction with each other; consequently, the hard section is driven into the soft, displacing the original structure at this point and making it unfit for any purpose; unless the piece is cut off at this point when dressed it is liable to break off by dropping on the floor. To avoid this, heat your steel sufficiently to harden the whole length of the taper point, and retain heat enough in the body of the tool to draw the temper slowly; if the tempering is done too rapidly, or the blue color allowed to run too fast, then submerge in water to stop its further progress. At the junction of the bright and blue color the hard and soft section is formed with the above results. The color should run very slowly, so as not to produce any sudden change in the structure of the steel when tempering. The above articles refer to tools that are subject to impact force or heavy blows, such as stone cutter's tools, chipping chisels, etc.

"Improper manipulation in forging causes many imperfections in steel tools. When the piece to be forged is of uneven shape, the force of the blow from the hammer must be governed by the section of the piece it is shaping. In nine cases out of ten, where chisels are found cracked on the corner, it is caused by striking the edge of the chisel when too cold, causing compression to take place a little below the surface that received the blow. Some persons claim that these cracks are caused by uneven heating before hardening; others call them 'fire cracks.' Admitting the fact that uneven heating will produce similar flaws to those referred to, my experience has taught me that they are mostly caused by improper hammering on the anvil.

"Steel tools that have to be finished in the lathe or planer, such as taps, dies, milling tools, etc., great care should be taken in forging. If the steel has to be reduced from a large to a small section, bring the steel to a bright red heat for the purpose. Every blow struck should affect the piece from surface to center; if the piece is worked too cold, the blows affect the piece only partially through its section, causing two structures in the same piece; consequently, the uneven structure will maintain itself through all the operations in finishing the tool, and when completed it will not give satisfaction. This class of tools, after being finished, will come back to the smith to be hardened.

"The conditions in heating steel for forging purposes, and heating finished tools for hardening, are vastly different;

in the latter case great care must be taken in heating; the whole piece to be hardened should be heated slowly and uniformly over the whole piece, as some steel will harden at a lower heat than others. The smith should know, before heating a costly tool, the necessary heat, when plunged into water, to produce the hardness required; over-heating in this case means destruction to a costly tool. If it is a complicated tool, having delicate projections, baths should be prepared, which are not as good conductors of heat as the bath for ordinary purposes, as the slender projections will cool much more rapidly than the body of the piece. Oil is often used for this purpose, but any liquid will answer that will give the thin projections sufficient time to cool, at the same time producing the hardness required. We should always bear in mind that it is the time it takes a piece of steel to cool that determines its hardness, other conditions being equal."—President Wren at Convention of National Railroad Master Blacksmiths' Association.

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Paper Friction Wheels.*

BY W. F. M. GOSS.

If two toothless wheels are pressed face to face, the rotation of one will tend to turn the other, and under favorable conditions power may be transmitted from the driver to the follower. Such an arrangement may employ all the forms common to toothed gearing, but as the contact is one of pure rolling such gearing is freed from some of the limitations which govern the use of toothed wheels. For example, in friction gearing the driven wheel may be disengaged and stopped without danger of shock, while the driver continues its motion, or if out of gear it may as readily be started, its speed accelerating until it becomes normal.

The amount of power which can be transmitted by friction gearing depends upon the characteristics of the material used in the two wheels which run in contact. As usually constructed, the driver is made of yielding material, such as wood, rawhide, leather, or india rubber, while the driven wheel is almost invariably of cast iron. Such combinations have the advantage of producing a high co-efficient of friction between the wheels; and again, if there is slippage, it is the harder wheel that stops, and upon this the continuous motion of the softer driver inflicts no damage. Until quite recently all such gearing has been of light construction, and the power transmitted correspondingly small, and so long as leather and raw-hide continued to be the materials most preferred for the construction of drivers, no very heavy work was practicable.

There has recently appeared, however, a new material which seems well suited to the requirements of friction wheels. This is compressed straw-board, and as in belt transmission the paper pulley has earned for itself a well-merited place, so in frictional work the paper friction wheel is fast paving its way to general recognition. These wheels are composed of thin disks of straw-board cemented together under heavy pressure and strengthened by iron side-plates, or fitted over iron centers. By this construction the face of the wheel presents the edges of the straw-board disks, and these give a surface which takes a good finish when turned, and which works perfectly in rolling contact with cast iron.

Some of the applications of the paper friction wheel are presented diagrammatically herewith. Fig. 1 shows a plain gearing connecting parallel shafts. Friction wheels of this form are in service which are capable of transmitting twenty-five or more horse-power. A three-wheel gearing, which is considerably used as an element in the feed mechanism of certain sawmill machinery, is shown in Fig. 2, the combination being one in which a paper wheel acts as a medium by which motion is transferred from one iron wheel to another. Another typical gearing is shown in Fig. 3. If the paper driver of this gearing is forced against the rim *a*, a forward motion of the follower results, while if the driver is brought in contact with *b*, a reversed motion at higher speed is obtained—an arrangement which has been found serviceable on screw presses. Beveled paper friction wheels of the form shown by Fig. 4 are being made of such size as will permit their use for driving shop shafting, while Fig. 5 shows a device which has been employed for giving motion, in either direction, to the spindle of a well-known shaping and panel-carving machine.

In the absence of data which would serve as a basis for calculating the amount of power which any paper wheel can transmit, an experimental study of the problem was resolved upon, and with this end in view apparatus was devised which is shown diagrammatically by Fig. 6. The shaft *A* of this figure runs in fixed bearings and carries the paper friction wheel; it is designed to be driven by belting from any convenient source of power, the direction of the motion being that indicated by the arrow. The shaft *B* carries the iron follower and the brake wheel. The bearings of this shaft are capable of receiving motion in a horizontal direction, and by means of suitable mechanism connected with them, the iron follower may be made to press against the paper driver with any force desired. The pressure exerted by *B* upon *A* is the "pressure of contact," and is represented by *P*. Through the action of the brake, the tendency of the iron wheel to revolve with the paper wheel may be resisted to any desired degree, and the theory of the machine assumes that the energy absorbed by the brake is equal to that trans-

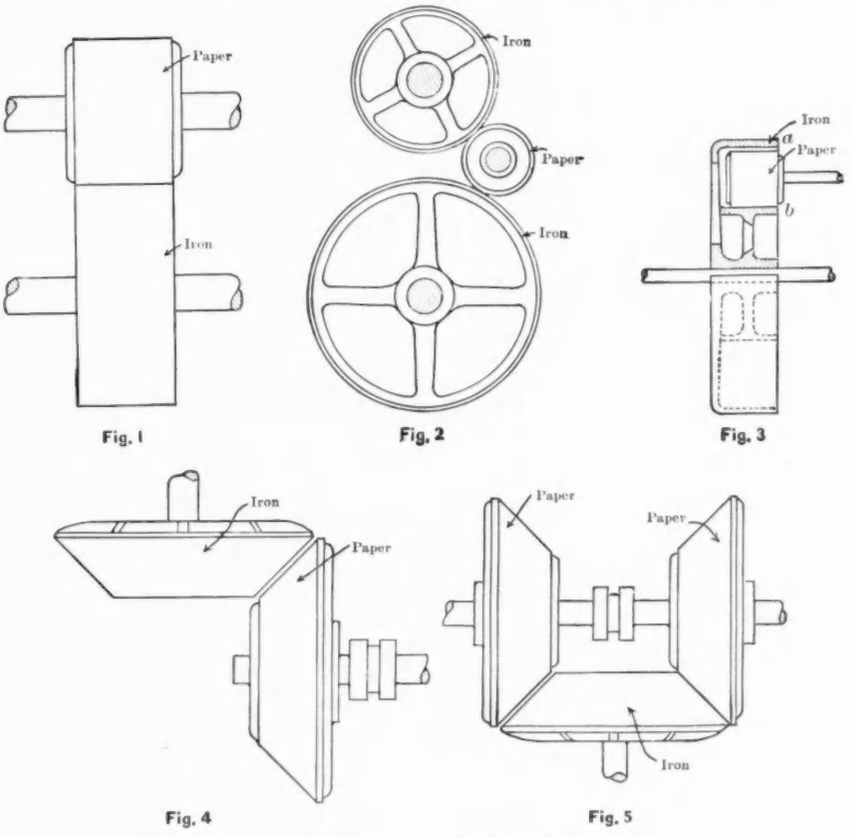

Fig. 1 Fig. 2 Fig. 3

Fig. 4 Fig. 5

PAPER FRICTION WHEELS.

* From a paper read at the December meeting of the American Society of Mechanical Engineers.

mitted from the driver to the follower at their point of contact C. The resisting force of the brake may readily be reduced to an equivalent force F, acting at the circumference of the follower, and its value may be accepted as the force actually transmitted from one wheel to the other at the point of contact C.

From this brief description it will be evident that the functions of the apparatus are such as will permit a study of the relationship existing between F and P, which relationship may be expressed as the co-efficient of friction, thus:

$$f = \frac{F}{P}$$

Other things being equal, the power which can be transmitted by any such gearing will vary directly with the co-efficient of friction.

The actual machine used is shown by Fig. 7. It meets all the conditions which have been defined, excepting that the shaft B does not run in frictionless bearings, as a strict adherence to the assumed theory would require. It is thought that, during the experiments, the journal friction at B was fairly constant, and that its value was always small as compared with that of the forces transmitted by the gearing. Its effect, so far as it may have had an effect, would have been to reduce the value of the observed co-efficient of friction. The values as observed, however, are doubtless better for the purposes in hand than a true value, since the employment of friction wheels in practice will generally involve losses by journal friction similar to those existing during the progress of the experiments in question.

By reference to Fig. 7 it will be seen that the fixed bearings of shaft A are fitted between guides in such a manner as to allow the bearings of the shaft to be blocked out towards B, in case a friction wheel is to be experimented upon which is much smaller in diameter than the one shown. The bearings of B slide at a good fit between the guides in the frame, and the pressure of contact between the friction wheels is secured by weights on the holder E, acting through a bell-crank and suitable connecting links. The fulcrum of the bell-crank is in a block G, which may be adjusted by the hand-wheel H, thus allowing the arms of the bell-crank to be brought to their normal position, and in this way offsetting slight variations in the diameter of the friction wheels. Power was delivered to A by two three-inch belts, and was absorbed at B by a rope dynamometer. Slippage was determined from readings of counters taken simultaneously from each shaft.

In carrying out the experiments it was found convenient first to load the weight holder E, Fig. 7, and then to bring the bell crank to its normal position by adjusting the trunnion block g; the follower was thus made to roll with the driver under a definite pressure of contact. By applying the brake a light resistance was then introduced to oppose the motion of the driven shaft, and this was maintained constant for a sufficient period to allow observations to be made for slip.

The pressure of contact, the load on the brake, and the slip having been observed, a new set of conditions was obtained by increasing the brake-load, after which, observations were repeated. In this manner a series of observations was made under a constant pressure of contact, but at different brake-loads; and as each increment of brake-load increased the slip, the resulting data gave the relation between the percentage of slippage and the force transmitted for the pressure of contact chosen. When the brake-load had been so much increased as to make the slippage excessive, a new value for the pressure of contact was chosen, and the whole process as already described was repeated.

The results were finally grouped for purposes of comparison, in such a manner as would make each group present but a single variable factor (Fig. 8).

The experiments involved paper friction wheels, of approximately 5½, 8, 12 and 16 inches diameter, all in contact with a 16-inch cast-iron wheel. The contact pressure was varied from 75 pounds per inch of width to more than 400 pounds, and the speed limits gave a peripheral velocity varying from 450 to 2,700 feet per minute. In an effort to eliminate all inconsistencies the work was many times repeated, the whole process involving more than 5,000 observations.

The following is a summary of results:

Slippage.—By increasing the load to be carried, the slippage may always be gradually increased to three per cent., and

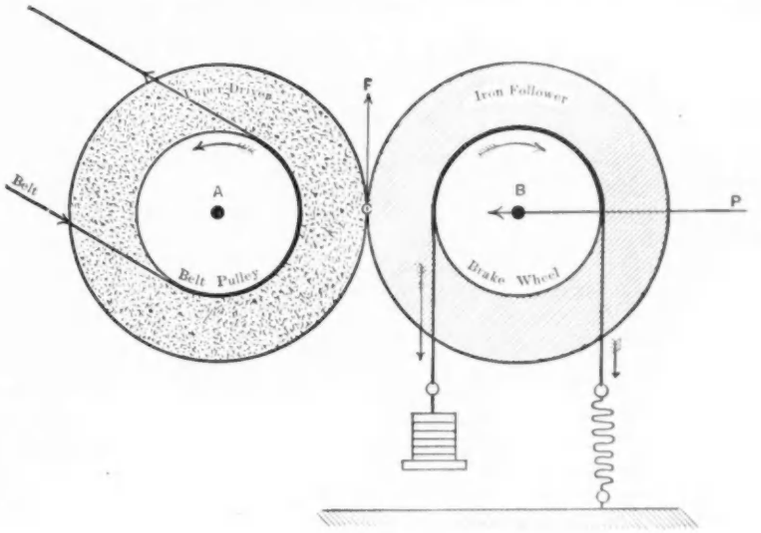

Fig. 6

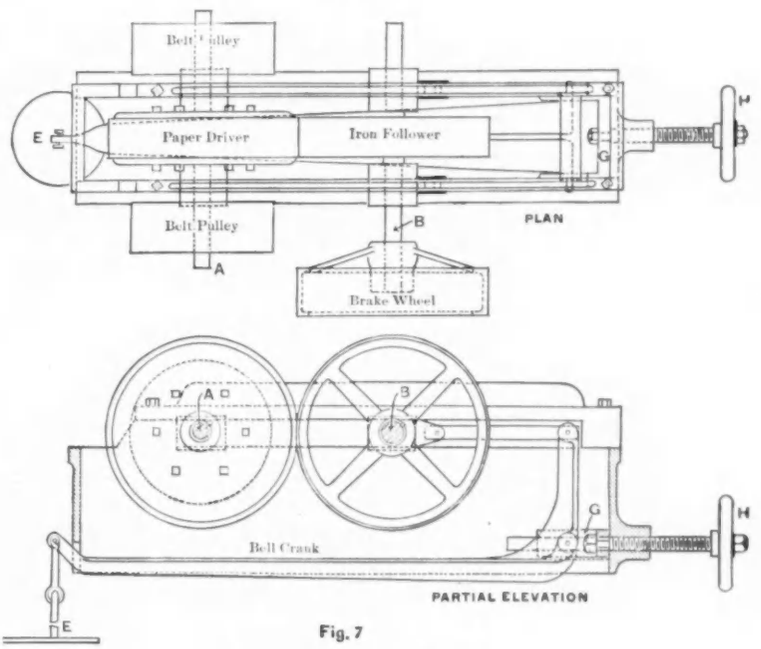

Fig. 7

PAPER FRICTION WHEELS.

under favorable conditions its gradual increase may reach a maximum of six per cent., but when the slippage is between the limits of three per cent. and six per cent. it is likely to undergo a rapid increase to 100 per cent.; that is, the driven wheel is likely to stop.

The Co-efficient of Friction depends upon conditions some of which have not been studied and are not understood. It is most affected by slippage. Its value increases with increase of slip until the latter becomes about three per cent., after which the action of the gearing becomes uncertain. With a slippage of two per cent., the maximum value of the co-efficient rises above twenty-five per cent., and as the slippage approaches three per cent., even larger values have been observed. Fig. 8 shows a relation between slippage and the co-efficient of friction,

Pressure of Contact.—With a constant co-efficient of friction, the power transmitted varies directly with the pressure of contact. During the comparatively short period covered by the experiments, the paper wheels gave no indications of breaking down under pressure as high as 400 pounds per inch in width. The work was not continued through a period sufficiently long, however, to permit a determination of the maximum pressure with which paper drivers may be forced against their iron followers; but it has already been noted that the co-efficient of friction is maximum under a pressure of about 150 pounds per inch in width, and while the amount of power delivered may be augmented by increasing the pressure above this limit, the most efficient pressure is that for which the co-efficient of friction is maximum.

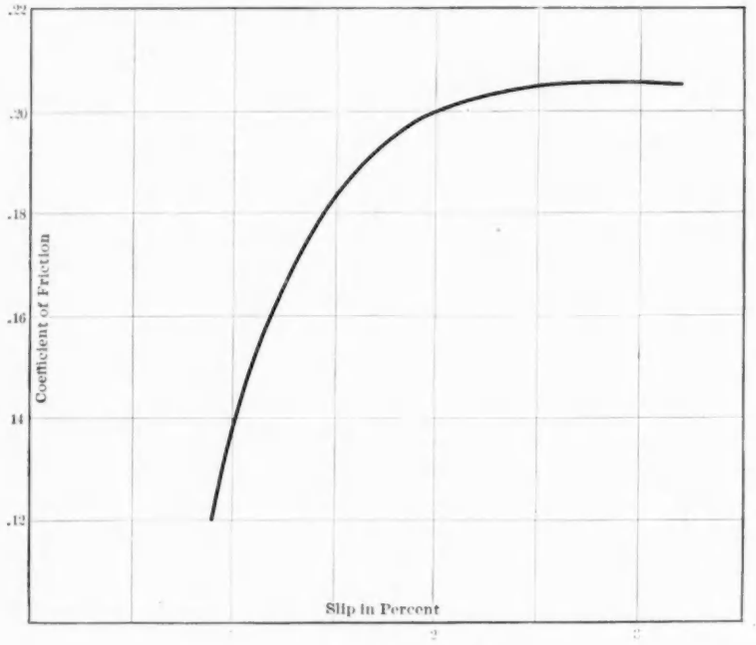

Fig. 8. PAPER FRICTION WHEELS.

which can easily be maintained with paper friction wheels of 8 inches or more diameter.

The co-efficient of friction is apparently constant for all pressures of contact up to a limit which lies between 150 and 200 pounds per inch of width of wheel-face, beyond which limit its value decreases. At 400 pounds pressure its value is from ten per cent. to fifteen per cent. less than for 150 pounds.

Friction wheels of 8, 12 and 16 inches diameter give nearly the same value for the co-efficient, while results from a 6-inch wheel are lower by about ten per cent.—a fact which would seem to indicate that wheels smaller than those experimented upon may have a still lower value for their co-efficient.

Variations in peripheral speed between 400 and 2,800 feet per minute do not affect the co-efficient of friction.

Horse-power.—By making d the diameter of the friction wheel in inches; w the width of its face also in inches, and N the revolutions per minute, and by accepting 0.2 as a safe value for the co-efficient of friction, and a pressure of 150 pounds per inch width of face as the pressure of contact, the horse-power may be written as,

$$H.P. = \frac{150 \times 0.2 \times \frac{1}{12} \pi \, d \times w \times N}{33000} = .000238 \, d \, w \, N.$$

This formula is believed to be safe for friction wheels which are 8 inches or more in diameter, and under conditions which make it possible for them to be kept reasonably clean.

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Some of the great manufacturers are now using iron or steel visiting cards. Those of Count Renard are said to be only 1-1,000 inch thick, those of Baron Krupp 1-820 inch, and Count Horroch's are 1-640 inch.

Fits.

The following query has been handed to us with a request for an answer: "Can you find me, in any book, a rule governing fits, measuring from 1 foot to 24 feet, for driving, shrinking or working fits?" The question was originally addressed to the librarian of a well-known library, and from him we received it. It is evidently asked in all good faith and in the child-like belief that it will be fully answered. It is assumed, of course, that the answer exists and that nothing is required but to lay the hand upon the volume and the finger upon the page.

Fits always mean fine or correct work. If a thing fits, that is the end of the job. But our fine work does not get into the books, and fits, as the culmination, the satisfying result, of the best work, are the last things that we should look for in the books.

The question above is embarrassing to us also in another way. The range of dimensions given is almost beyond the limit of what are generally known as mechanical fits. Shrink fits are often employed of almost any size, but instances of tight driving fits or loose running fits of 1 foot in diameter and upward, with solid shaft in a continuous hole, without adjustment or take-up, we do not happen to think of. They seem to be such an impossibility that they are not even attempted. Besides the careful turning and boring, means seem to be always provided for adjusting the one to the other. A piston must fit its cylinder, but the packing rings make the final fit; a fly-wheel must fit tightly on its shaft, but it is usually made in halves and bolted together to pinch, and keyed besides. Another kind of fit is required for the shaft in its bearing. Here it must fit quite loosely, but no one knows very clearly how loosely, as means are always provided for adjusting the one to the other.

Fits that are made with the aid of calipers, and which bring the external and internal cylindrical surfaces to the proper tightness or looseness of fit without the aid of compensating or adjusting devices, are, as we have said, usually of dimensions considerably under 1 foot in diameter. And even with these, little has got into the books. What "art and mystery" there is to the trade of the machinist is in calipering probably more than anywhere else. It cannot be communicated by the most wordy instruction, and can only be learned by the doing of it. And men never learn to do the simple operation of calipering alike. What is known to the trade as "iron and iron," or the exact diametral identity of the turned shaft and the bored hole, will mean a very tight fit from the hands of one workman, and not a very tight fit from the hands of another. The finish of the surfaces calipered has usually much to do with the accuracy and closeness of the calipering. If the surfaces where the dimensions are taken are fine

and smooth, the fit should be expected to be more accurately determined than if the surfaces were coarser and rougher; but, unfortunately, the coarser and rougher surface conveys more sensation to the calipering fingers than the finely finished surface can. So the futility of attempting to describe and fix the conditions of accurate fits is apparent. The conditions of the surfaces calipered, the rigidity of the calipers and the personal equation of the individual are all more or less indeterminate and inexpressible quantities.

As to an all-embracing rule or series of rules for fits, or for the relative external and internal diameters for different sizes and different conditions of tightness, we do not know of their existence and do not know where to look for them, and we could not think them deserving of much confidence if found.

Some examples of what is possible in the way of rules for fits, we find in locomotive practice. Eccentric rod pin bushings are forced in by hydraulic pressure of about 4 tons, driving-box brasses with a pressure of 5 to 7 tons, and crank pins are forced into the hubs with a pressure of about 6 tons per inch of diameter. Here no attempt is made to give the calipering. A 4-inch axle is turned .015 inch larger than the hole in the wheel, and the wheel is pressed on with a pressure of 30 to 35 tons. In shrinking tires on driving wheels, the tires are usually bored 0.0126 inch smaller per foot of diameter than the centers upon which they are shrunk. Not many data are to be found even of this unsatisfactory character.

"No fresh truth ever gets into a book," as was written many years ago, but comparatively fresh ones are often to be found in the best technical periodicals, and it is well to keep a constant lookout for them, and catch them as they fly.

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The Engineer in Naval Warfare.

BY AN EX-NAVAL ENGINEER.

"If a thousand old beliefs were ruined in our march to truth, we should still march on."

The symposium of four prominent line officers of the navy in the December number of the "North American Review," referred to in the "American Machinist" of December 24th, would be humorous did it not constitute so labored an effort to conceal from the public view the real merits of a question of the highest importance to the country. This latest attempt to bolster up the long-standing antagonism to the reasonable claims of the engineer corps has evidently been long in preparation, as a reply to the series of papers published in the May number of that periodical under the same caption, and can hardly fail to assist every unbiased mind to the conclusion that they are among the most remarkable specimens of special pleading ever seen in public print.

They all set up that very rickety old man of straw, the alleged desire, or demand, of the engineers to be put in command of ships, and devote about twenty-six pages of the "Review" to his demolition. The whole series is so absurd, not to say disingenuous, that it can do little more than show to what insignificant proportions prominent men can sometimes shrink.

Besides that very stale old bugbear, the alleged aims of engineers to command ships, the most prominent scare-ghost in these discourses is the real claim of the engineers to positive rank and title, in place of the present mongrel things known as relative or assimilated rank, and titles which they assert are descriptive of or define the duties of the officers bearing them.

In the matter of command, Admiral Walker says: "Military ideas must be the controlling ideas, the military element must be the predominant element, and the military men who train the crews in warlike exercises, and who in battle will employ and direct all the weapons of offense and defense, must exercise authority and command." This is a typical specimen of their special pleading. Who of them can point to a single instance where naval engineers have disputed this or claimed a prerogative which would in the slightest degree derogate from or interfere with such authority and command? It is a man of straw, simply, which has been so often set up and knocked down that it can now scarcely be gotten upon its legs.

The command which the engineers desire, and of right should have, is that which would give them sole control over their own men and material, subject, themselves always, to the so-called "military element." But such control would not permit this element to directly and indiscriminately command the men and material of the engineer's force, which, in these days of steel steam fighting machines, constitutes so large a proportion of the crew and appurtenances of a warship, nor anything appertaining thereto, except through the officers who train, control and should command them.

On the modern war vessel, constituting as it does to so great an extent an aggregation of machinery (the design and product of the engineer) whose care and manipulation involve a number of men constantly increasing with the increase of mechanical factors of the ship, it follows that the engineer's responsibility of command must keep pace with the growth of the force required for the care and operation of all engineering appliances; and as the navy is essentially a military establishment, the command of any considerable body of men is of necessity of a military character. The naval engineer is in reality as intrinsically military in this command as are the line officers on deck or behind the guns. All parts of the naval vessel legitimately coming under the supervision of the engineer, are as essential factors in or out of battle as the guns themselves; and the attempts so often made to place the engineer corps in the category of non-combatants on shipboard have long ago lost their meaning, owing to marine developments. The engineers are as much military men as the line, and there is not the slightest justification in the latter arrogating exclusively to themselves the term "military element."

The commander of the ship commands everything thereon, as by right he should; just as a major-general commands his division; but he has certain subordinate officers through whom he reaches everybody; and similarly, the officer of the deck, himself subordinate to the commander, has the proper channels through which to reach those over whom he is placed in control, and for the time being he is in absolute command of the engineer of the watch, and all under him. But this gives neither the commander nor the officer of the deck the right to go over the head of anyone to reach subordinates under his command, any more than a major-general would give an order to the captain of a company directly over the head of his superior officers in the regiment. No line officer on board of ship has the right to directly and indiscriminately command everything and everybody below him. This is he merest A B C of disciplinary command.

But the trouble is that such a commonsense state of things cannot be tolerated by the line without wounding their *amour propre*, where an engineer is concerned. What is so persistenly harped upon as the "military element," seems to think that indiscriminate command of everybody and everything, under any and all circumstances and conditions, is theirs by some sort of divine right; and that to condescend to make a request of, or to consult with an engineer about something pertaining to the latter's functions, would deprive a line officer of something peculiar to, or inseparable from, his so-called "military position."

I need not offer instances of the endless troubles which have arisen in the navy growing out of this matter of indiscriminate command. Their name has been legion and their import serious enough; and but for the unexampled forbearance of engineers under provocations of this character their results would in the past have been a hundred-fold more serious.

One of these writers seems to regard it as a strong point for them in this controversy, that there are some supposed conditions in other navies, in a way, parallel to what they contend for here, but, while here there may, in some measure be foundation for their opposition to the suggested modifications of rank and title, they carefully conceal that in no single naval service does the indiscriminate right to command obtain which they claim in ours; nor do they find anything approach-

ing it in the merchant service of any country.

So far as rank and title are concerned, what have we to do with foreign navies anyway? Why should we pattern after them as to this any more than we should construct our government itself after their models. Our navy personnel would be more consistently constructed as differently in this respect from that of Russia, for example, as is our republican form of government from the government of the Czars. In point of fact the present formulation and distribution of rank and title in our navy is but a relic of that very autocracy which we as a nation long ago condemned and discarded; as are many others of the traditions of our naval past, to which the present line of the navy so persistently clings. They are in the main obnoxious to the spirit of our government in their past and present application to the modern steam marine, and our navy will never be as distinctively American as is our National establishment until it has been divested of the hoary old world spirit of autocracy which has so long enthralled it. The martinet is slowly disappearing from all navies, but his lingering existence in ours has less justification than in any other.

So far as the mere question of command is concerned, as a matter of discipline and good government of the vessel, a captain or his representative, so called, is as much bound to obey—yes, obey; that's the exact word—the engineer or the surgeon or the paymaster in his specific sphere as is either of these to obey him in all else. If we give to the commander of a vessel the right to indiscriminate command under any and all circumstances, or to his subordinates, as by a convenient fiction representing him, we simply arm him or them with a power for mischief which all human experience teaches will too often be exercised, and of which the experience of not only every engineer, but every staff officer as well in either corps of the service furnishes endless examples. It has been the cause of most of the troubles in the navy for the past half century. Do we need instances? We have had many. The writer gave one in a recent number of the "American Machinist," as a part of his own experience, in which the success of a whole squadron, in a projected battle, was jeopardized by one of these autocratic orders, as ignorant as autocratic; and there is no lack of similar instances since the advent of steam in the navy.

Admiral Walker says: "They [the engineers] claim that steam has revolutionized navies and that the engineer has practically superseded the seaman," but such palpable misrepresentation as this will never serve to shut out the causes for the claims really and properly made by them. "It is a very narrow and limited mind," says the Admiral, "which sees in a great art one only of its applications. Seamanship has not passed and will not pass. As long as ships float upon the sea there will be sailors in command." All of which is mere speciousness of a very inferior quality. Engineers claim no such thing as is here imputed to them, nor do they wish or expect ever to be placed in command of ships as such—except, perhaps, in such an emergency as would call them to this duty as the only resort. Being rightfully in command of large forces of men at all times, it would naturally and rightfully fall to an engineer officer to command in a case where all the officers of the line of sufficient experience and rank might be placed *hors du combat*.

The engineer knows very well that seamanship and military command are neither of them obliterated by the passing of sail power; but the sailor officer does not yet seem to have learned that he cannot replace in himself the mere management of the sails, in his repertoire of acquirements, with an equal proficiency in the management and care of the extensive and intricate steam machinery essential to the modern naval vessel, or that the latter constitutes a prominent part of a profession which, as a whole, requires a lifetime of study and experience for its mastery.

Oh! but they say the exercise of this profession of engineering is not required at sea, we need there merely "engine drivers," and that it is all wrong to commission men to perform such duties, and to invest them with rank and title. To be sure, one of these writers does admit the necessity of one commissioned engineer on ships above a certain size and class, and that he should be an educated engineer in all that the name implies; but that to have such on watch is too great a luxury. Why, then, have any commissioned, titled sailors standing watch? Simply because in both cases, one as much as the other, these duties constitute a great part of that training, experience and education necessary to ultimate proficiency in higher duties. How do these people propose or expect to procure accomplished chief engineers for sea and other duties in the naval establishments without that experience which can only be gained on watch at sea? Why is not engine-room watch duty as essential to the equipment of a competent chief engineer as the similar subordinate occupation of junior officer of the much vaunted "military element"? Why in the days of sail power were junior line officers required to go aloft, furl sails and perform pretty much every duty legitimately devolving upon the enlisted sailor, except as required to fit him to become a competent commanding officer at sea? And since it is admittedly a vastly more extended and exacting acquirement to be able to perform the duties of a watch engineer than all that pertains to the mere management of the sails of a ship, why should not this duty as necessarily become the school for chief engineers as the former that of the commander? And if necessary to commission and confer rank and title upon the one, why not upon the other?

Every line officer is required to go through certain subordinate experiences before he rises from any rank to a higher one, and these experiences he must have before he is entitled to command in what the Admiral calls the "Great Art." It should be and is, no less true as to the equally great art of engineering.

"The seaman of any age," says Admiral Walker, "must understand all the forces with which he has to deal and in the present day must understand steam. He need not be an expert, practical machinist, but he must know the limitations of steam machinery, and the laws of its care and use."

If this means anything, it is that it replaces in him the knowledge of sails and their management previously, but not now required in a sailor officer, with an equal proficiency in steam machinery, or else by the advent of steam his role at sea or ashore has been so greatly augmented as to include all that constitutes the profession of mechanical engineering. How worse than absurd is all this when aside from the management of the sails all that otherwise constituted seamanship and the military functions in the sailor officer is still required in him; thus comparing the mere management of the sail power of the bygone ship with the intricate mass of steam and other machinery upon which every function of the modern warship so greatly depends.

Then observe: "He need not be an expert, practical machinist." Among all the supposed titles in the navy, that of machinist, as applied to the person in charge of an engine room watch at sea, is the greatest misnomer. That there should be one or more machinists on every considerable steam vessel is as true as that in sailing ships a sailmaker was required, but only in a parallel capacity; and there is no one of the labored efforts of the line to discredit the position of watch engineer, and through him every sea going engineer and the whole profession of engineering, so transparent as this attempt to foist upon the service the title of machinist for a man expected to perform duties as far removed from those of an expert machinist as is the modern surgeon from an apothecary. This whole machinist idea and the title used in this connection is a logical outgrowth of the long continued efforts of the line to disparage a profession whose rising importance at sea they have so jealously feared, and this fear finds expression nowhere more completely than in the series of articles under discussion. Men who labor at the fabrication of bicycles, sewing, and an endless variety of other machines, are as much machinists as those who merely labor in the construction of steam en-

gines, but the latter, as a machinist, is no more an engineer than any of the former.

After recommending a change in our service which would place always "skilled machinists on watch in the engine room * * * who would not rise above warrant rank," Admiral Walker says: "Such a change would not only be good administration in itself but would relieve the navy from the discontent now felt by highly educated young men who go to sea in the position of engineer of the watch.

"This position, I repeat in conclusion, depends upon its duties, and its occupant cannot rise above them, no matter what his intelligence, education or professional value." But why should this be any more true of the watch engineer than of the junior line officer on watch on deck? Both are undergoing subordinate experiences necessary to their mastery of, and ultimate proficiency in, their respective professions. Can the Admiral tell how he came to rise above the subordinate duties he once performed, or has he not in reality yet risen above them? It is as indispensable that young engineers perform the duties of the watch at sea, in order to become properly educated and experienced chief engineers—as these people are reluctantly forced to admit is indispensable to every considerable steam vessel—as that a junior line officer should perform similar subordinate duties to qualify him to become a competent commanding officer; and all attempts to replace junior engineers with what they are pleased to misname machinists, who, as such, are not even "engine drivers," and who must not be permitted to rise above their occupation, are of a piece with the long-standing and continuous efforts of the line to discredit a corps whose necessary acquirements have come to be as essential to the efficiency and well-being of the navy, in peace or war, as is their own.

The logic of naval development requires, merely, that the corps of the line conform to the changed conditions, and without in the least detracting from its legitimate prerogatives; but in order to do this the officers of this corps must become prepared to recognize the necessary, and as legitimate, prerogatives of an element which these changed conditions have brought into existence on shipboard. When they come to this, as they must, and not till then, the rightful place of the engineer in naval warfare will be found.

JOHN T. HAWKINS,
Late P. A. Eng., U. S. N.

(To be concluded next week.)

▲ ▲ ▲

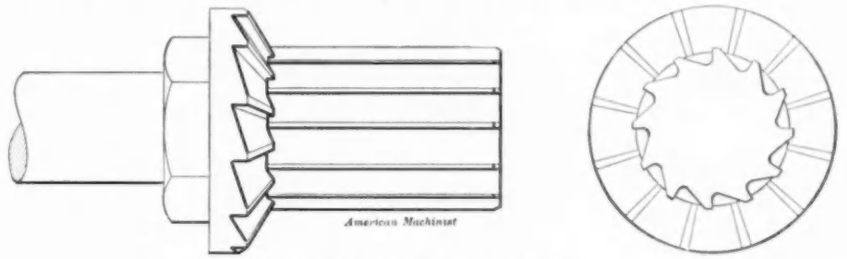
One volume of petroleum vapor renders 380 volumes of air explosive, and 1,150 volumes inflammable. A red hot piece of metal or coal or a spark from steel or flint will not ignite an explosive atmosphere of petroleum, but white hot metal, flame, or electric spark will.

Chattering Reamers.

BY FRANK RICHARDS.

Chattering seems to be always more or less of a nuisance. Sometimes it is bad and sometimes it is worse, but in the machine shop it is usually in the superlative degree and is there peculiarly detestable. I, of course, have had some experience in the reamer business, as well as those who have been telling us about it lately in the columns of the "American Machinist," and my experience has been along pretty nearly the same lines as theirs. I have had chattering reamers and I have generally found some way of curing them, or sometimes someone has found the way for me. A chattering reamer, by the way, is not a reamer at all, as it does not do the work for which it is intended.

I remember that I once made a reamer like the sketch here, that I thought was pretty good at the time. Anybody can easily see how it was made. There was the straight reamer with the shank all in one piece, made of good tool steel, and then there was the cutter for the bevel seat, that was made as a collar and fastened onto the back face of the straight reamer with the nut behind it as shown. The bevel seat cutter had as many teeth as the flutes in the straight reamer, and they were made to project in between the reamer teeth, with the result that the corner of the valve seat was not left sharp and raw, but was as smooth as could be desired. The reamer worked beautifully and was used for a long time for the special job for which it was made.



REAMER FOR VALVE SEATS.

That is to say, it did very nice work after it was broken in. The first valve seats that I tried it on were so bad, on account of the reamer's chattering, that I had to throw them away, and I was in a lot of trouble over it. While I was looking the reamer over and thinking of throwing it away, too, George W. Richardson came along, the pop safety valve and balance slide valve man. He seemed to know right on the spot what to do with the reamer, and he did it. He did practically what Mr. Almond and Mr. Hemenway have spoken of. The reamer had centers in each end, and there was an empty lathe next to mine. George took the reamer to the lathe and put it on the centers, so that he could whirl it easily with his hand, and while he whirled it, touched the straight teeth lightly with an oilstone, and the reamer was struck dumb from that moment and never chattered again. The touch was so light as not apparently to dull the reamer; but it did the business, and the reamer was not ground or sharpened again as long as I knew it.

A great many persons, at one time or another, have tackled the problem of the chattering reamer, or, rather, it has attacked them. When the factory-made reamers were first put on the market, it was soon said of them that they were very nice, but they chattered too much. One of the things easiest to think of, by way of a remedy, was to make the flutes spiral instead of straight, and they were so made, still retaining the regular spacing. It was then found, of course—although the "of course" came slowly—that the reamers chattered as badly as before, only making spiral chatters instead of straight ones. Then came the somewhat sensible suggestion of irregular or differential spacing for the teeth, and this has been generally adopted, with results more or less favorable. If the teeth are not spaced regularly, the similar elevations and depressions of the internal cylindrical surface, where in the chatter movement all the reamer teeth may concur, become necessarily more minute, and if the chatters do not entirely disappear, they at least become much finer. In the "American Machinist," more than eight years ago, I did a little figuring on the possibilities of differential spacing, and I found that with thirteen teeth to the reamer they could be so spaced that, to have all the teeth at once coincide with the chatters, the smallest number of chatters in the circle or revolution must be 1,560, and when we get them down as fine as that, it would not be strange at all if they should disappear entirely. If a differential spacing of reamer teeth is attempted, better results may be secured by going at it systematically than by any haphazard or guesswork differentiation.

And now, after all, it really seems that a combination invention is what is needed in this case. Although the differential spacing is better than the regular spacing, we can afford to do away with that, too, and still do better reaming. The idea exists in Professor Sweet's last letter to the "American Machinist" on this topic, but it does not seem to be carried quite to its legitimate conclusion. He speaks of a taper reamer with spiral flutes, but with different rates of spirality, some of

the cutters being more spiral and some less so. Now, such a reamer must be rather troublesome to make. I know it would work all right; but I, unfortunately, am quite a stickler for the symmetrical, and it therefore could not possibly suit me. It would not look pretty, and so I certainly would not have it. Space the reamer perfectly regular, and cut the teeth all with the same spiral; but, instead of a constant twist, let it be a gain twist, and you will have the handsomest reamer that ever greeted mortal eye, and it will not chatter.

That may do for a taper reamer; but how about a straight one? Well, a straight reamer has to be to a certain extent a taper one, or it will not be able to do any reaming. After the hole is cut or reamed to the full size, the shape or disposition of the reamer teeth which may pass the hole after it has thus reached its full enlargement can have no further effect upon its final condition, and cannot change or alter it even by scraping out a chatter mark. If the hole is chattered, it will be chattered before the reaming is completed; and if it is to be cured of its chatters, that also must be done before the job is finished. We must assume, then, that the straight reamer is to some extent taper, and that successive portions not in the same radial plane will be cutting at the same time, and in that fact we will find the means of curing all chattering or of all tendency to chatter.

I would cut a straight reamer perfectly symmetrical and regular. I would make it with an even number of flutes, and I would make one-half of the teeth straight or parallel to the axis, and one-half of them spiral, following each other alternately, first a straight one and then a spiral one, all around the reamer. This would involve a constant differentiation that could not fail to prevent all chattering. The teeth should be so arranged that at the middle of the cutting length of the reamer they should be all spaced equally around it, and then the difference of the spacing, due to the spiral being contiguous to the straight teeth, would have the least effect in the arrangement without impairing the function in cutting.

Fellows who tell about what has been done, and what is being done, are on much firmer ground than those who tell about what might, could, would or should be done. On second thoughts, I am rather inclined to hedge a little about the taper reamer with the gain twist flutes, unless the taper is comparatively slight and the reamer advances rapidly. The other reamer with the alternate straight and spiral flutes, I have considerable confidence in.

▲ ▲ ▲

The electric wires of the city of Baltimore are to be placed under ground. A subway commission appointed for that purpose has just made its report and submitted plans for the work.

Repairs of Electrical Machinery.—II.

BY A. R. HARRIS.

In a previous article on this subject, it was shown that the principle of winding ring armatures is very simple, but that sometimes the arrangement of the coils is such that it is not easy to determine which are the proper ends to connect. In the following an effort will be made to show how the difficulties may be overcome.

In the great majority of cases, the coils are wound so as to fill all the space from the core to the outside of the wire; that is, each coil is made to occupy all the depth of the wire. Occasionally, however, the coils are superimposed upon each other, this being done either to make the winding easier, or else so as to be able to get a greater number of turns on the armature. Figs. 1 and 3 show two different ways in which the coils may be wound when they are arranged on the armature in a single layer, and Fig. 2 a superimposed coil winding. In the three figures, the part of the coil located on the outside of the armature is shown in section.

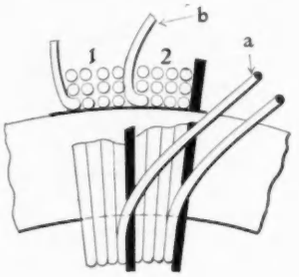


Fig. 1

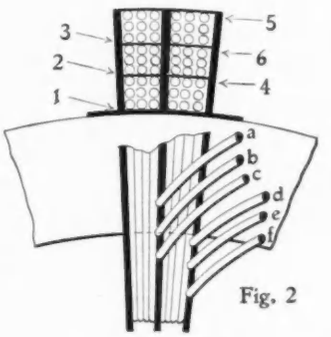


Fig. 2

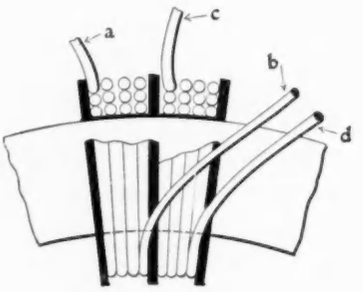


Fig. 3

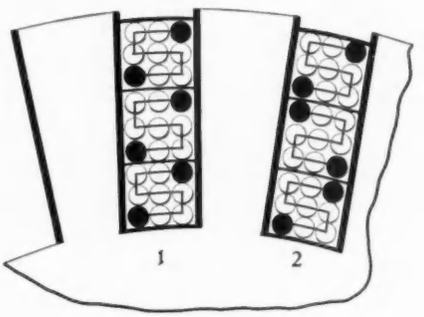


Fig. 4

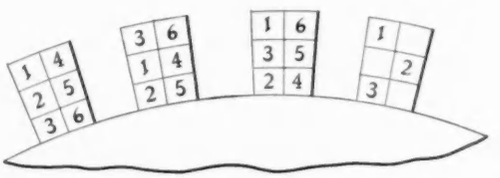


Fig. 5

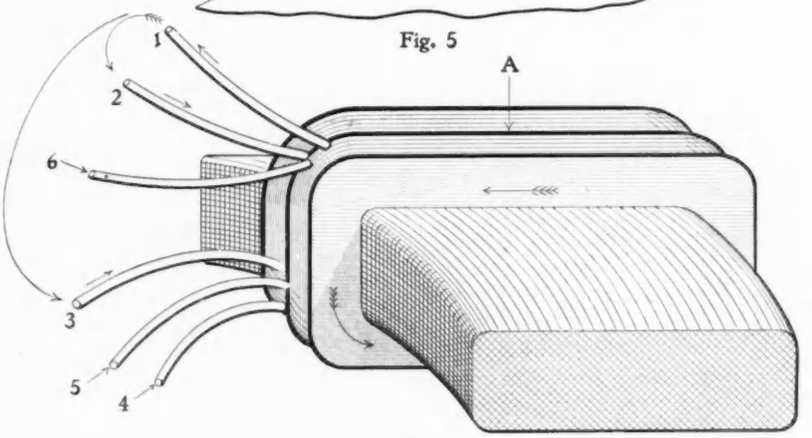


Fig. 6

American Machinist

REPAIRS TO ELECTRICAL MACHINERY.

The winding shown in Fig. 3 is the best one, and is used in the great majority of cases; but that shown in Fig. 1 is not uncommon in machines made by some concerns. In Fig. 1 it will be noticed that the top end of the wire is at the bottom of

the coil, while in Fig. 3 it is on the outside surface. The latter winding is superior for two reasons, one of which is, that as both ends are on the outer surface, if either one should break off it can be easily spliced. The other reason is, that in the process of manufacture, the end coming from the bottom of the coil, in Fig. 1, is sure to be bent back and forth a number of times, and, as a consequence, will be left in such a condition that it will break off, under the crystallizing action due to the vibration of the wires when the machine is in use, much sooner than if not subjected to so much bending. The electrical action of both windings is the same, and an armature wound with both kinds would work as well as if with only one; therefore, as that shown in Fig. 3 is by far the best, whenever it becomes necessary to put on a new coil it should be wound in that way.

To wind a coil with both ends on the surface, all that is necessary is to commence from the center of the wire and wind both ways. This is accomplished by taking a length of wire sufficient for a coil and winding it on two shuttles, one half on each; then one shuttle is passed around the armature core in one direction, and the other in the opposite direction.

As to the connection of the ends of these coils in the proper relation, there is very little danger of making a mistake, if it is kept in mind that an outside end must connect with an inside one, and further, that the ends must belong to adjacent coils. In Fig. 1 it is easily seen that the outside end *a* of coil No. 1 must be connected with the inside end *b* of coil No. 2; for *a* comes from the inner side of the armature core, and *b* from the outside. In the same way, in Fig. 3 the end *b* of the left-hand coil must connect with end *c* of the right-hand coil.

If the simplicity shown in the foregoing were always encountered, there would be very little danger of making false connections; but in cases where the coils are wound one on top of the other, as shown in Fig. 2, it is generally difficult to pick out the right ends. To facilitate this matter as much as possible, the ends coming from the under side of the core are brought to the surface at about the points shown by wires *a b c d e f*, and the ends coming over the top of the core hold corresponding positions on the upper corner of the coil. If the entering ends of the coils were always on the same side, as indicated by the arrows 1, 2, 3, there would be no danger of connecting wrong ends; but it is as common to have the ends come from both sides as from one. Fortunately, coils are seldom wound on top of each other in armatures where the whole surface is covered with wire, this winding being more frequently met with in grooved armatures, and in these there is a chance to trace the wires between the coils, and thus determine where they come from. Fig. 4, which shows two grooves of a grooved armature with three coils in each, illustrates how in one case all the upper ends may come from one side of the coils, and in another case may come from both sides. In both the grooves the black circles indicate the first and the last turns in each coil. In groove 1 the first turn of each coil is on the left hand side, and the successive turns are arranged as indicated by the line running through the circles. In the groove 2 the inner and outer coils commence on the left side, but the center coils starts from the right. In both cases it must be remembered that the end of the coils would not come out where the last turn is shown, but would continue around the armature core and come out on the under side, as shown in Fig. 2.

If in Fig. 2 all the coils were wound as in groove 1 of Fig. 4, it would make no difference whether *a*, which is the end of coil 1, were connected with the beginning of coil 4, 5 or 6. Neither would it make any difference if the winding were as in groove 2; but in this case, as one of the wires issuing from the space between two sets of coils would belong to one set and the other two to the other set, it would be very possible to connect with a coil in the wrong group, by following this careless method. This point can be better understood by reference to Fig. 5, in which four sets of coils are shown in different arrangements, the connection being in the order indicated by the numbers. In the group to the left, the end of the top coil connects with the beginning of the middle one, and this with the bottom one, which in turn connects with the top of the succeeding set. In the second group, the middle coil connects with the bottom one, and this with the top, which connects with the middle one of the next set. In the third group, the top coil connects with the bottom, and then with the middle, and from here goes to the bottom of the next set. In these three groups it will be seen that there is no regularity as to the order in which the coils are connected that belong to the same set, but in no case does a coil of one set connect with a coil of another, unless it is the last one of the set; that is, 1, 2, 3 may be arranged in any way so long as they are on top of each other, but they could not be as shown in the group to the extreme right.

To determine which are the ends of the respective coils, so as to be able to connect them properly, is not so difficult as may appear. Suppose you have a case as in Fig. 2, where six coils are disconnected and all the rest of the armature to the right and the left of them is perfect. There would be twelve ends to trace out and connect in proper relation. The ends coming from the inside of the armature could be easily separated from those on the outside, as they would issue from points nearer the center of the shaft. Whether the coils are wound as in groove 1 or 2 of Fig. 4, can be determined by noting from which side of the insulating partition they come. This is shown in Fig. 6, in which it will be seen that the wire 2 does not come from the same side of partition *A* as wire 1, and that wires 3 and 4, coming from the under side, are not on the same side of *A* as wire 5. Wires 2, 3 and 4 therefore belong to the set of coils on one side of *A*, and 1, 5, 6 to coils on the other side. Now wire 1 could not be connected with 2, because both are top wires and the current would run back through 2 in a reverse direction. The proper connection for 1 would be with 3 or 4.

After having determined to which set of coils the ends belong, and which are inside and which outside ends, it is necessary to connect them in proper succession, and also with the uninjured part of the armature, so that the current through them may be in the right direction. To accomplish this, ascertain whether the end wire of the perfect part of the armature, either to the right or the left, comes from the inside or the outside; the source from which one or the other end comes can surely be made out. Having determined this point, commence to connect the loose ends from this side. Take wire *f*, if the end of the perfect wire is on the outside, and by means of a magneto bell find out which of the three outside ends it belongs to, and connect this end with *e*; find the end of *e*, in the same way, and connect it with *d*. Find the end of *d* and connect it with *c*, and so on for the other wires. Having done this, connect top end of *a* with wire from perfect part of armature on the left; then connect the junctions *a b c d e* and *f* to the commutator, in regular succession.

The order in which the coils in any set are connected may be changed as desired, but the connection with the commutator must be such that each section is connected with a coil that directly succeeds the coil with which the preceding section is connected. As this point is one of the most important to observe, it will be explained fully in another article.

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The Sleepy Eye Rotary Engine.

So many of our readers are genuine inventors and interested in patents existing and in patents prospective and in the realization of pecuniary returns from them, that we seem to be under some obligation to mention again the Sleepy Eye rotary engine.

In our issue of December 17th last we mentioned, as we got it from the daily papers, that Grant Brambel, of Sleepy Eye, Minn., had sold to an English syndicate all proprietary rights in his rotary engine for $1,600,000. Since then the story has grown, and the latest form of it is as follows:

"Sleepy Eye, Minn.—Grant Brambel, who invented and patented a rotary engine, to-day transferred the right to manufacture and sell the engines to Henry

Francis Allen, representing the Allen syndicate, of England, for $3,100,000. This sale is for only the United States—England. Germany, France and Europe having been previously sold for over $4,000,000. The inventor yet controls the engine for Mexico and the Canadian provinces."

The engine invented by Grant Brambel and patented in December, 1895, we consider far from the best and not far from the worst of existing rotary engines. It is demonstrable from the patent drawing that the steam will not turn the engine over except when started from one or two special points of the revolution, and if it could be got to run, it would do little more than that; and whatever the volume or pressure of steam used, little power could be developed. The Brambel patent claim is one of those all-comprehensive combination claims which, covering so much, really cover nothing. It is the style of claim which the "no patent, no pay" attorney delights to secure for his client. Any slight deviation from the details of the combination breaks the claim completely. If, as we understand, this inventor has been exhibiting an engine in operation and developing a respectable amount of power, it is morally certain that it has not been built in strict accordance with his specifications, and that it is, in fact, an unprotected invention.

It is proper to say that we do not believe the story of the sale of the above alleged invention, or any part of it. All the rotary engine patents in existence could be bought for much less than is alleged to have been paid for this one, and they would be dearly bought at that; and the money would not be extracted from any British syndicate, none of whom, as a rule, are in the habit of paying out fabulous sums for chimerical inventions.

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Broaching Machine.

We give herewith an engraving of a new broaching machine intended for such work as is done on bicycles and in similar lines. It consists essentially of an upright plunger which is driven by rack-and-pinion movement, as indicated, the two pulleys being driven in opposite directions and alternately connected to and disconnected from the shaft by means of clutches, one of which is placed at each end, the two being connected by a rod which passes through the shaft.

The length of stroke is determined by the position of the collar on the top rod at the right, and the driving clutch is thrown into engagement by the lever also at the right. The pulleys are 16 inches diameter, 3 inches face, and the gearing is sufficiently powerful for the class of work indicated.

When set for general use, the machine makes a complete stroke and returns, and then stops until it is again tripped, though the trip can be so arranged that the machine will run continuously if desired. It is made by the W. P. Davis Machine Company, Rochester, N. Y.

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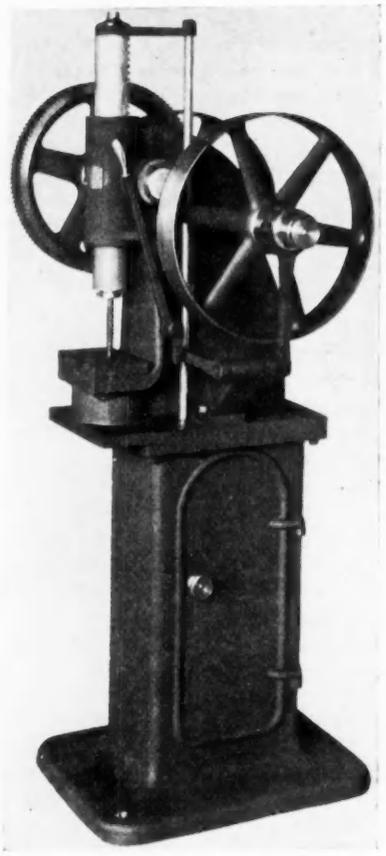
Letters from Practical Men.

Measuring Minute Intervals of Time.

Editor American Machinist:

In the recently published "Text Book of Ordnance and Gunnery," by Capt. Bruff (which I assume to be the United States Government Manual), the only chronographs described are the Boulengé, Schultz and Marcel Deprez. I



BROACHING MACHINE.

may therefore be pardoned for reminding your readers that these instruments have for some time been superseded by the Zamanap. As is well known to those of your readers who are interested in artillery, or in obtaining very accurate records of the movements of machinery at high speeds, the great defects of the Boulengé dropping bar chronographs are:

1. Great number of batteries needed, and consequently
2. Want of portability.
3. Delicate adjustment of resistances necessary, and consequently are
4. Troublesome to get ready for action.
5. Variation with the latitude, altitude and hight of barometer.
6. Only one interval of time can be measured.
7. Owing to the sluggishness of the magnets, errors arise which cannot be measured, and therefore
8. The indications cannot be depended on.

Considering these defects, each of them fatal, it is surprising that the apparent simplicity of this very erratic and troublesome instrument should have led to its adoption. That, however, was because the other chronographs offered were invented by outsiders without the practical experience to show them what was really wanted. Hence these instruments would only serve in the scientist's laboratory, where an hour or so spent in adjustments every time of using was of no consequence.

A favorite form depended on the use of a tuning fork, and it was confidently proposed that the vibrations of this fork, as they marked themselves on a smoked surface, were authentic records of time.

I must ask your readers to bear with me while I point out the fallacy of such a supposition. In the first place, a tuning fork has this fundamental defect, that it is impossible to know exactly how many times it vibrates in a second. The period of vibration of a tuning fork varies with

1. The comparative density of the atmosphere. With a high barometer the resistance to its vibration is greater, and consequently that vibration is slower.
2. The temperature. In hot weather the tuning fork is longer and thicker than in winter; hence, it vibrates more slowly.
3. The tracing point for marking the smoked surface, however light it may be, adds to the mass of the fork and increases its period of vibration.
4. The amount of soot on the surface cannot possibly be regular, and the resistance to the motion of the tracing point will thus continually vary.
5. We have no means of ascertaining what correction to make for the foregoing errors.

Your readers will thus see that using a tuning fork to measure time is like drawing a line, calling it an inch long, solemnly dividing out that unmeasured line into a million parts with a micrometer, and then gravely using these subdivisions as millionths of an inch.

At Greenwich Observatory the transits of the heavenly bodies are recorded on a drum chronograph. The drum is so shaky as to be easily moved about a quarter of a second. The records are measured by small flexible scales which can be bent round the drum. There are six of these scales, not one of which agrees with the circumference of the drum or with any other of its fellow scales. Yet the results which may be half a second out are gravely set down to two places of decimals.

In "Engineering," page 26 of July 3, 1896, we are informed that the revolution of a shaft may be accurately counted by one man feeling the revolutions with his finger and calling out the numbers to

another man who holds a common fifth-second stop watch. We never know what we can do until we try.

Realizing the need of an efficient instrument to measure high velocities with accuracy, I first brought out, about 1891, a small pocket affair combining a revolution counter and a chronograph. When this was applied, say, to a shaft, one part registered the number of revolutions while the other indicated the time that had elapsed since the counting began. Thus it was completely automatic; and on disconnecting, it showed that in say 25.3 seconds the shaft had made 729 revolutions. That was very useful to electricians, and indeed to all who had to do with high speed engines; but to be accurate it was rather expensive. Latterly I see the idea has been taken up in a cheap form, but of course with infinitely less reliability.

To measure the speed of ships or projectiles demanded something more, and after about four years I perfected a chronograph of the printing kind, a variety which had been frequently tried before, but without success. This form of chronograph registered to $\frac{1}{1000}$ second and gave every satisfaction; it registered an exact fraction of an exact second.

There I might have rested, but I saw the possibilities of the principle I had adopted; and although much hindered by long and tedious illness, as well as by the malicious burning-out of my laboratory; I had in about four years more finished an instrument that gave an exact $\frac{1}{10000}$ second. It is an instrument adapted to the roughest usage, although so accurate. I call it the Zamanap (from the Sanskrit). It needs only one or two small cells of battery and is perfectly automatic.

Its most important uses have been to measure speeds of ships on trial trips, and to measure velocities of projectiles. For the latter it has the advantage that velocities may be obtained, not at one point, as with the other chronographs, but at any number of points in the path of the shot. Moreover, by the use of certain apparatus which replaces the screens of wire or thread, no time is lost by replacing these between each shot. It has taken eight different velocities of each bullet fired from a Gatling gun operated by electricity at the rate of about two thousand shots per minute, taking sixteen thousand records per minute without straining itself.

I put it to another curious use: Armed with a small Zamanap, which with its battery would go into my hat, I went into Westminster Abbey and set it in motion while the organist was struggling through one of Henry Purcell's anthems. On measuring, I found some of the notes were about half and others double their proper length, but hardly any of them were right, and those only by accident.

SIR C. PURCELL TAYLOR,
Bart., D.Sc.

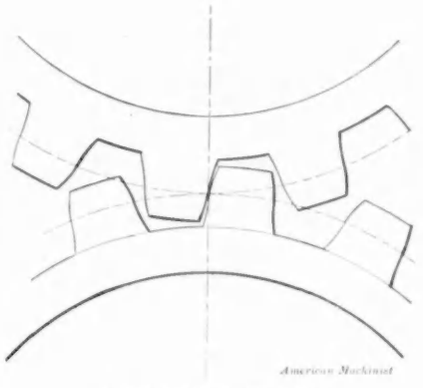
London, England.

Short Gear Teeth.

Editor American Machinist:

I have read with much interest the letter on gear teeth, of Mr. Horace L. Arnold, in the "American Machinist" of January 7th; the more so as I have been preaching the doctrine of shorter teeth for a long time, and one of my letters drew out a favorable comment from Mr. W. H. Booth some two years ago. The long tooth, of 0.70 or 0.75 of the pitch, is a survival of the past, when both shafts and bearings were less rigid than is the practice to-day, and when gears, being simply cast from wooden patterns, were liable to be more or less eccentric and to require much more length to insure contact.

As gears are made now, I see no reason for a greater length than 0.60 of the pitch, and for cut gears of 0.50, as is also suggested by Mr. Arnold. If the thickness of the tooth at pitch line is 0.46 of the



SHORT GEAR TEETH.

pitch, the strain at the root comes very near to that which may be placed upon a cube; and if the tooth is slightly widened at the base, as it may easily be, by rounding off the point with a proper curve, without thereby diminishing its strength, we can get the full strength of the cube for the cantilever, which the gear tooth is. Then, if we assume the breaking strain of such a cantilever, as shown by Mr. West's experiments, published in the "American Machinist," as 8,000 pounds per square inch, a strain on the point of the tooth of 500 pounds will give a factor of safety of 16 to 1, which ought to be ample for any purpose.

The last illustrations to Mr. Arnold's paper represent very closely what a gear tooth should be, in my way of looking at it; and with such gears my table of the safe power to be derived from gears, published in the Journal of the Franklin Institute some ten or a dozen years ago, and which was calculated from this "cubic strength" as a basis, should be found amply satisfactory for all ordinary practice.

I quite agree with Mr. Arnold in condemning the practice of fine pitch and many teeth, which obtained in many of our shops in the past; but I think this was done to insure constant contact of one or more teeth, and to avoid the chatter which might come from the yielding of weak shafts or bearings, thus permitting instants of no contact, if the teeth were coarse and open.

I inclose a sketch showing my idea of a correctly proportioned tooth for a pair of 16-tooth pinions, in which

width of tooth = .46 pitch;
width of space = .54 pitch;
hight of tooth = .50 pitch;
clearance at bottom = .05 pitch.

SAM'L. WEBBER.

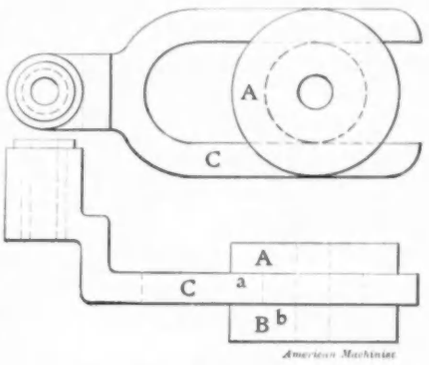
▲ ▲ ▲

A Handy Guide for Hand Taps.

Editor American Machinist:

Can you put me in the way of getting some idea of the best way to make a cheap and handy guide for a hand tap, so that I can tap holes true and without a lot of trying with a square, and then not a very good job after all? W. T. B.

[Everyone knows, of course, that our correspondent is not up to date or he could hardly be making the above inquiry. As a general thing, if it is known that a hole is to be tapped, the right time to tap the hole is at the time that it is drilled, and the machine that will drill the hole correctly should also be able to do the tapping. We are aware, however, that there are some places where this practice cannot be carried out. Nothing that we could suggest for our correspondent's purpose would be universally applicable, but the rig shown in the sketch might do very well. We have a disk *A* say 3¼ inches diameter and ⅝ inch thick (none of the dimensions that we may mention need be followed), with a boss,



A HANDY GUIDE FOR HAND TAPS.

say, 2 inches diameter and ⅝ inch thick, solid with it, the faces *a* and *b* faced parallel to each other. The lower disk *B* is of any convenient thickness to give the right hight to the tapping guide, and when the guide is wanted down close to the work, this lower disk may be dispensed with entirely, and the upper disk *A* and its boss may be bolted down onto the surface being tapped, if it is true. The fork of the tapping guide *C* is faced thin enough to slip under the face *a* without binding. The hub of the tap guide, if it is for taps up to 1 inch diameter, has a

true vertical hole through it a little larger than the largest tap to be used, and into this is dropped a bushing that will fit the shank of the tap, and, of course, a different bush will be required for each size of tap. We assume that the tap will center itself by the hole, and the guide will do nothing but keep it always perpendicular to the face. By using a strip of paper on each side, or by facing the hub a little shorter, the guide may be held rigid when the central bolt is tightened. With the guide not bound, however, it will be easy to slip it out of the way, or to command several holes with one bolting. It is certainly well to remember that the practice of tapping any hole without a guide for the tap is a relic of the dark ages, though it is still sometimes necessary, and the tapping of holes by hand may before long be as infrequent as hand drilling.]

▲ ▲ ▲

A Mysterious Explosion—Boring Bars.

Editor American Machinist:

I was recently called to take measures for new plungers in a waterworks plant. The pumps were compound duplex, and the water plungers were 16 x 48 inches, cast hollow, with flanges on each end, to one of which the piston rod was attached; the other was a plain flange. Both flanges were fastened to the plunger with cap screws and were an air-tight fit, so that the plunger was supposed to contain nothing but air while it worked against 100 pounds water pressure. In taking dimensions it became necessary to remove the plain flange. The cap screws were taken out, and the flange not coming off readily, it was hit with the end of an iron bar to loosen it, when there was an explosion and the flange was blown out of the pump, grazing the engineer's leg and hitting a post some feet away, making a large dent in the post. The flange came out with force enough to have broken the engineer's leg if it had hit him square. At the same time there was a puff of steam or gas from the pump. Afterwards there was a lighted candle held in the end of the plunger, when there was another slight explosion and puff of gas.

Now, what was the cause of the explosion? Perhaps there might have been a little water that had worked through the plunger, and with the air already in the plunger it had formed an explosive gas, athough the plunger showed no signs of rust inside. The precaution was taken to drill a small hole through the flange in the rest of the plungers, when the same explosive gas was found as in the first plunger. The same conditions may prevail in hollow piston heads that some foundrymen use to blow up their cupolas with, although if the same foundrymen would read the "American Machinist" they would know better. Possibly some reader of the "American Machinist" can throw some light on this explosion business; at least it seems that it is best to be cautious about knocking heads off of plungers of this kind.

BORING BARS.

I would like if some of the craft would write their experience in boring cylinders, pumps, etc.; what kind of bars, number of cutters used, etc. In my experience I have had the best success in getting a round hole with four cutting tools in boring head; I have used 3, 2 and 1 cutting tools in head, but could never get as round a hole as with four cutters, although I could get the smoothest-looking job with one cutter. I once had a machinist in my employ, from the State of Missouri, who strongly recommended me a bar that they used in his country with seven cutting tools in the boring head, but I did not think I would have patience enough to set seven cutters so that they all would cut alike, so did not try the plan. He also told me of a mandrel they used for truing up piston rings, which is not very costly, to say the least. This wonderful mandrel was made from a white oak log, as long as would go in the lathe. You drive a piece of iron in each end for centers; turn the log up tapering; turn and cut off your piston rings in the ordinary way; then drive them on the log and face them up; and when the mandrel gets worn you can regrind it, so to speak, by simply putting a lathe tool in the lathe and turning it up again.

C. C. SPRAGUE.

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Cutting Keyways.

Editor American Machinist:

Those who have cut keyways that were required to be straight and true in holes that were small and long, can appreciate the difficulties that sometimes arise when

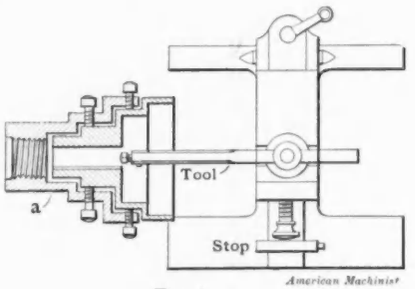


Fig. 1

keyway cutters or special tools for that purpose are not at hand. Having a number of small lathe cones that were to be bored and keyways cut, the following method was used with very satisfactory results:

The cones were held in the lathe in a special chuck *a*, Fig. 1, and the holes were bored and reamed with rose and fluted chucking reamers held in the tail stock. The tool for cutting the keyway was made by forging a tool much the shape of a boring tool, as shown in Fig. 2. In the end at *C* was inserted a cutter of the desired width, held in place by the set-screw *S*. The tool was held in the tool post of the lathe and adjusted to the proper hight to pass through the hole, the same as a boring tool. By locking the cone and throwing in the back gears, the work can be held still. The lathe is then converted into a hand shaper, the tool being passed through the work by moving the carriage back and forth along the bed by hand. By using the stop usually used for inside screw-cutting, the

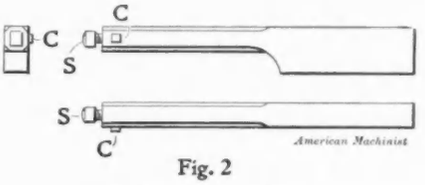


Fig. 2

CUTTING KEYWAYS.

tool may be moved back from its cut while the carriage is being run back, thus avoiding the danger of breaking the cutting edge of the tool by dragging it back in its cut, and at the same time providing a means for regulating the depth of each cut.

This method saves the time of resetting the work if the keyway were to be cut in another machine, and gives a keyway that is straight and true with the hole, both having been cut with one chucking.

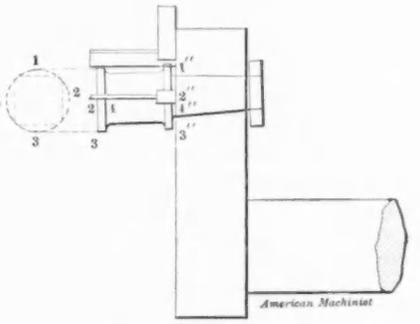
W. P. TURNER.

▲ ▲ ▲

A True Crank-Pin in an Untrue Hole.

Editor American Machinist:

Not long ago we had an engine shaft in the shop with the crank pin loose. It had been a constant source of annoyance, and finally could not be held any more. It was not only loose, but was not square with the face of the crank, which was true. The pin was about 3¼ inches diameter by 4 inches long, and on the length of it was out of square about $\frac{1}{16}$ inch. The way we remedied the trouble was by making a new pin and first fitting the taper part and marking it so that we would get it in the same way again. We then filed four spots on each collar, 1, 2, 3, 4,



and 1", 2", 3", 4", getting them square with the crank face and parallel, and recentered the pin by these spots and then finished turning the pin. We put back the pin according to the marks and we had a good job, giving satisfaction. It may be

old, but to us it was new, and we give it for what it is worth.

F. FUERSTE & SON.

Guttenburg, Ia.

[The trick is one that it is well to remember. We have known more than one case where the parties went to the trouble of reboring the hole, involving more expense than this mode of turning the pin, while the result was practically the same. —Ed.]

▲ ▲ ▲

Some Points About Boring Bars.

Editor American Machinist:

We have been having something recently about boring bars, and some of my own experience with them may not be amiss.

We are all more or less familiar with the style shown in Fig. 1. It has a flat cutter which fits a slot, and the bar is flatted to a certain size *x*, to which the cutters are then fitted to center them.

The size *x* is often quickly lost. The cutters may be the right size to fit it; but unless the shoulders are precisely square they will cut their way to a seat; and then, too, I have known a bar to be filed when

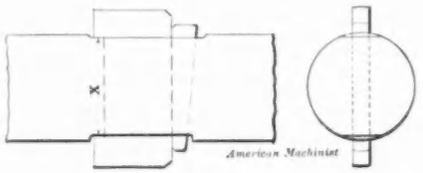


Fig. 1

THE REGULAR THING.

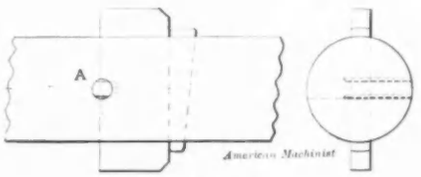


Fig. 2

ANOTHER IMPROVEMENT.

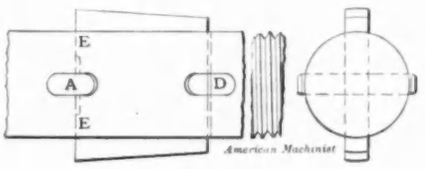


Fig. 3

ANOTHER BORING BAR.

a cutter was a little too small, thus fixing it so that no other cutter previously made would fit it.

The bar shown at Fig. 2 is, I believe, my own improvement on Fig. 1, the object of this construction being not only to avoid this mutilation of the bar, but also to so arrange that the same cutter could be used in several different-sized bars, if desired. The pin *A* is round, but is flatted for a portion of its length for the cutter to fit over. This pin should be tempered.

A short bar, say 8 inches long, can be kept in the tool-room to fit cutters to; they can be turned to size in this short bar, and if the pin is put in exactly central, cutters will always fit and bore their proper size.

At Fig. 3 is a bar having a taper cutter. In this case the wedge *D* forces the cutter against the bar at *E E*, and both wedges must be driven out to remove the cutter. Wedge *A* fits the bar all around, but fits the cutter on the sides only.

This bar was once made with a 20-pitch thread and revolved in a stationary nut for the feed. This was all right for straight holes; but when it was one day tried on a taper hole, you may imagine there was a difficulty and that someone learned something about boring taper holes and taking broad chips.

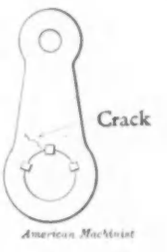
F. J. WOODHURST.

Keys Hold a Cracked Crank.

Editor American Machinist:

I notice in your issue of December 10th, on page 1143, Fig. 2, an arrangement of keys which is very good where there is a heavy strain. By referring to the "American Machinist," Volume XVI, January 5th, page 5, Fig. 4, you will find just the same arrangement in 1893.

In 1876, having to use a pair of 12 x 20-inch engines for a hoist at the Ontario Mine, Park City, I found that one of the cranks was cracked from the key, and it being extremely difficult at that time to obtain another, I used the arrangement sketched, which has been in use ever since. The center key was eased so as to bear on



the edges only, and the other two keys were fitted easy on the sides and driven by their edges only, so as to hold the crack together and keep it from opening out. Being a reversing engine, of course, rendered the strain more severe.

WM. J. SILVER.

Salt Lake City.

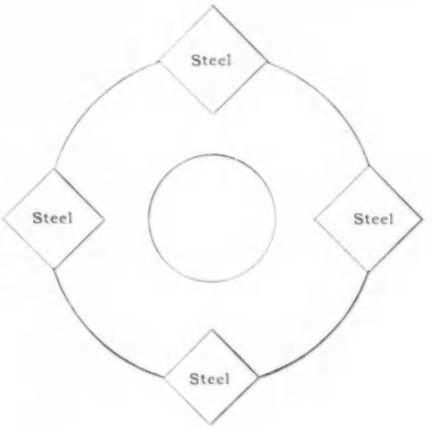


Fig. 1

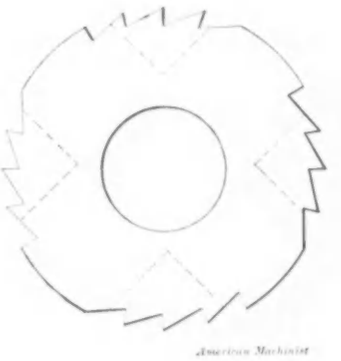


Fig. 2

REAMER WITH WELDED-IN TEETH.

Reamer with Welded-in Teeth.

Editor American Machinist:

Reading Mr. Hemenway's account in your last issue, of a large reamer made partly of iron, reminded me of the reamers I made before solid emery wheels for grinding hardened steel were much in use. The great trouble with "all steel" reamers of large size was the liability in hardening of their becoming oval, or any shape except round. Knowing that iron was not troubled so much in that way, by heating and cooling, I took pieces of good quality, planed grooves as shown in Fig. 1, and welded in pieces of square cast steel.

In the welding, the projecting corners were beaten down to near the diameter of the iron. After turning, the portions of steel would appear as the dotted lines show in Fig. 2; and, as it was then supposed that uneven teeth would prevent chattering, no attention was paid to uniformity, but two or three teeth were put in each section of steel, the iron between turning a trifle smaller than the steel, being softer.

The hardening process changed the shape so very little that a slight application of oilstone was all that was necessary, and the reamer did as good work as any I see at the present time, used as I used them, in the boring lathe, on couplings, pulleys and similar work.

After that, all reamers over two inches diameter I made in the same way with satisfactory results.

O. C. CRANE.

312 E. 79th St., N. Y.

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An Unfair Report.

Our readers are already aware of Sir Henry Bessemer's paper, entitled "Historical and Technical Sketch of the Origin of the Bessemer Process," presented at the recent meeting of the American Society of Mechanical Engineers, and of the discussion which followed, in which were set forth the claims of Kelley and Mushet for a portion of the credit which Sir Henry contends belongs to him alone. We are both surprised and pained to read the report of that discussion which appears in "Engineering," of London, for January 8th, which report was contributed to the paper by its American correspondent. It is using very mild language to call this report garbled. Nothing resembling what the report gives as the adverse criticisms of the paper was said, while the strength of the criticisms actually made is either belittled or ignored. A worse case of misrepresentation has seldom come to our knowledge. The report is an absolute affront to every man who took part in the discussion; and, as a false statement of the proceedings, is an offense to the society at large.

Considering the character of the men who took part in the discussion, and, from personal knowledge, antagonized some of Mr. Bessemer's claims—than whom none stand higher in the metallurgical world—it is to be deplored that the English public should have this report of the discussion from a correspondent who seems bent upon ignoring the facts, and seems to feel himself under no obligation whatever to present an accurate and truthful report of what was actually said in the discussion.

Passing over here the matter of Kelley's claims as being open to misconstruction on grounds of nationality, this correspondent states that "it is well understood that the inventor who makes a process practicable is the real inventor." With this sentiment we have a good deal of sympathy, but a partisan of Sir Henry Bessemer is the last one who should appeal to this test, as by it the Bessemer process is not his.

Passing over the part played by the Swedish iron masters in pointing out the kind of iron necessary, it was Mushet who supplied the final step of the process which made it a success—the use of spiegeleisen for deoxidizing the charge. Sir Henry's claim that his use of cast iron for recarburizing anticipated Mushet's use of spiegeleisen for deoxidizing is the weakest part of his entire paper—its hollowness being apparent without argument. The chief similarity between cast iron and speigeleisen is that both come to the market in pigs.

Not only the matter, but the temper of the discussion was as far removed as possible from the representations of this correspondent. It was felt and expressed by nearly every speaker that Sir Henry's refusal to admit the just claims of others was a most unfortunate blemish on a great and richly deserved fame.

The spirit of fairness which characterizes the editorial mangement of "Engineering" is well known and has been the subject of recent comment in these columns. This report is signally at variance with the general course of that journal in its treatment of American engineering matters.

It is generally understood that Sir Henry Bessemer is one, if not the chief owner of "Engineering." But no fair-minded man will consider this to be sufficient justification for such an outrageously unfair and misleading report of the discussion on that paper.

It seems to be assumed that some members of the American Society of Mechanical Engineers are engaged in an attempt to deprive Sir Henry Bessemer of the credit really due him. This we do not believe to be at all true. The spirit which pervaded the discussion was simply one of regret that Sir Henry should ignore or deny the important contributory work of others—some of them his own countrymen—and the belief seemed to prevail that his own achievements would appear all the brighter if he could bring himself to see and acknowledge the historical fact that others besides himself have done at least something of importance in the development of the Bessemer process.

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Necessary Tools.

We have no higher aim than to be true to our name. We are of the shop first and always, and we are glad to know and proud to know that we reach every part of the shop, and have something for all that are in it. We receive letters of appreciation from high and from low in the shop, and also letters of inquiry covering all the range of shop interests. No letters are ever more welcome or receive more thorough attention than those of which the following is a sample. It is fresh from the mail as we write. The writer says:

"I have some questions to ask; I wanted to ask them long ago, but was afraid to on account of some geometry being in some answers I have seen, and that I could not understand. If given in that way they would be like so much Hottentot to me and to nine out of ten of my fellow workmen."

We do not know whether the "geometry" referred to was found in our columns or elsewhere, and we give ourselves the benefit of the doubt. The questions referred to will be answered in their proper place and with as little geometry, or Hottentot, as the cases will allow.

At the same time, we cannot refrain from expressing the wish that our correspondent knew something of geometry, if not of Hottentot. We are always sorry for a man who has not a good kit of tools, and especially if he wants to do any nice work. A good workman would be and should be ashamed to be found without proper tools, and he would be surprised if he found a fellow-workman getting along without them, and he certainly should not expect us to get along without them.

It may be very necessary to draw the line somewhere, but it must still always make a difference where the line is drawn. If we have not the best tools, we cannot be expected to do the best work. Our correspondent has no use for geometry, and it is therefore certain that he cannot do the fine work that geometry would enable him to do. If we draw the line exactly where he stops, we immediately encounter others not as well equipped as he, and then at their bidding we must set our limit still farther back, and so on indefinitely. Instead of our continually leveling ourselves down, it will be for the greater good of the greater number if they level themselves up.

While our correspondent ignores geometry, he probably fully appreciates the multiplication table; but he can never do with the multiplication table all that he might do with geometry, and it is absurd to expect it. Even he probably would not favor our drawing the line on the other side of him, at the request of the man who does not know the multiplication table and has no skill in its use. The man who still counts on his fingers, and goes no further, has just as good a right to ask that everything be explained, so that he can clearly understand it, as the man has who stops on the wrong side of geometry.

We propose always to do the very best we can for those who unfortunately have to confess that geometry is not in their kit; but we must also always feel impelled to say, as we have opportunity, that they are seriously handicapped by the lack of it.

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Technical Books.

ROENTGEN RAYS AND PHENOMENA OF THE ANODE AND CATHODE. By Edward P. Thompson. With a concluding chapter by Prof. N. A. Anthony. 190 6 x 9-inch pages and numerous illustrations. D. Van Nostrand Co.

This book gives a condensed account of the leading experiments and discoveries in connection with this newly discovered form of energy, going back to those experiments of the past which, not then fully understood, are now seen to foreshadow Professor Roentgen's great discovery. The various uses of the discovery in medicine and surgery are also gone into. The concluding chapter by Professor Anthony discusses the various hypotheses that have been offered in explanation. Professor Anthony concludes that "the burden of proof up to the present seems to be against any wave theory for the X-rays," although some of the latest experiments reported seem to remove some of the difficulties of the wave theory.

THE MACHINIST AND TOOL MAKER'S INSTRUCTOR. By Edward Genung, Mechanical Engineer and Machinist.

This is a book gotten up in the pocket-book style, and evidently intended to be used by machinists mainly, as it treats principally of those things which have to do with machine shop operations. It starts out with the usual instructions in elementary arithmetical matters, which, for some inscrutable reason, are supposed to be needed in such a work, but which can be found much better presented in the standard text-books, and it then goes on to a consideration of those problems in which the machinist is specially interested, and which are not to be found in text-books. Only a small portion of the book is entirely original matter, and while much of that which is original is valuable for those for whom it is intended, it would be more so had the author taken greater pains to be precise in his use of mathematical terms. It is, for instance, misleading to the practical mechanic to see an engraving of a chain link, having straight sides and semi-circular ends, called an "elliptical ring," and to be told that "a tangent is a straight line that touches a curve." We cannot see, either, how it helps to an understanding of the lever and other elementary machines, to give worked examples of problems concerning them, omitting all attempt to explain their principles. One who understands these principles seldom or never needs instruction in the arithmetic of them, and on the other hand, one who does not understand the principles involved in such elementary machines will be helped very little, if at all, by directions how to figure a few specific cases, unaccompanied by an attempt to explain the reasons for each step, or even by a rule which might be memorized. Some of the directions for laying off work are good, but the whole book needs judicious editing, and a judicious editor would have known that it is not proper to take from a book published by the Brown & Sharpe Manufacturing Company, a chapter credited in that book to the "American Machinist," without giving credit to the original source of the article. Failure to do this, and many other things we notice in the book, indicate that the author, however good mechanic or engineer he may be, has yet much to learn about book making. It has 264 4 x 6½-inch pages, is bound in morocco with pocket and flap. Published by the Genung & Smith Publishing Company, New Brighton, Pa. Price, $5.

▲ ▲ ▲

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(9) H. J. C., Milwaukee, asks: Is it possible to cut a left-hand thread with a right-hand die? A.—It is both theoretically and practically possible to do so. A single-thread die with two rows of cutters opposite each other would cut a left-hand single thread as well as a right-hand thread, except that there would be trouble about the clearance if the cutters were anything but points or thin sheets of metal. A single-thread right-hand die with three rows of cutting teeth would cut a double left-hand thread; a die with four rows of teeth would cut a triple left-hand thread, and so on. The cutting would not, of course, be clean and neat, but the cutting teeth would at least follow each other in the proper order and with the spacing to produce the result mentioned. The question is rather a theoretical than a practical one. These queer threads are, however, sometimes accidentally produced and require explanation.

(10) T. G. A., Fairmount, W. Va., asks: 1. Does greater velocity increase the strain on a rope hoisting a car out of a shaft, or moving one on a track? If so, in what proportion? A.—There is some increase due to the greater resistance at high speeds, but more due to the heavier shocks and to the strain of starting, which is not apt to be done so gradually as when low speeds are used. Within ordinary limits the increase would not be serious, but no rule can be given for it. 2. Do two steam cylinders, working on the same crank shaft—one at each end—give double the power that one would give? A.—Yes. 3. I wish to drive an 8-foot drum 40 turns a minute. Would a geared or direct-connected engine give the best economy? A.—A decision between a "first motion" and geared hoisting engine requires a careful study of all the particulars of a case. Geared engines are preferable with small loads and low speeds, and first-motion engines with the reverse conditions. The geared engine runs faster than a first-motion, and a smaller cylinder does the work—the saving in engines more than offsetting the cost of the gears. As the speed of hoisting and weight of the load increase, this advantage drops off, and finally disappears. In your case we should say that, unless your load is heavy, the advantage would be on the side of the geared hoist. With equally good engines there is no difference in the steam consumed, beyond the friction of the gearing; but, practically, first-motion hoists usually have better engines, and so give better economy.

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State of New York Stationary Engineers.

The first annual convention of the New York State branch of the National Stationary Engineers' Association took place in Albany, January 15th. The chief business of the convention was the discussion and drawing of a bill to be presented to the Legislature, requiring the licensing of stationary engineers. The bill, as prepared, provides for the appointment by the Governor of a chief examiner and six deputies at salaries of $3,000 and $1,800, respectively. Applicants for licenses must be examined and show themselves competent. Evasion of the law may be punished by fine not exceeding $3,000, or by imprisonment not to exceed 30 days. The officers of the State branch for the ensuing year are as follows: Past President, W. T. Wheeler, of New York; President, J. E. Reegan, of Utica; Vice-President, Nicholas Kelly, of Buffalo; Secretary, J. W. Hallenbeck, of Albany; Treasurer, Otto Hohensee, of Brooklyn. In the evening a banquet was enjoyed at the Delavan House.

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Speed Test of Compressed-Air Cars.

A special speed test was recently made of one of the Hardie compressed-air cars, which have now been running uninterruptedly for nearly six months on the One Hundred and Twenty-fifth street line, New York City. A speed indicator was attached, and continuous charts were made for two complete round trips between the North River and the East River. As the car was run as usual between the regular cable cars of the line, which follow each other at frequent intervals, it was difficult to find a clear stretch in which to acquire speed. No difficulty was experienced in acquiring a speed of 20 to 24 miles per hour between the streets. When running at 23 miles per hour, the car was stopped in about twice its length without jar or discomfort to the passengers. Running at nearly 20 miles an hour, it was

stopped within a little more than its length and without jar.

The driving power of the car was shown to be in excess of all needs. When the car was started at the near crossing, a speed of 8 miles per hour was obtained when the car passed the opposite corner. The power that may be applied is practically unlimited, depending merely upon the adjustment of the reducing valve for the working pressure.

Another special run of over 10 miles with one charge of air was also recently made by one of the cars over several connecting lines, affording all varieties of grade, curves, switches, load, stopping and starting, etc., and with a considerable surplus of pressure yet remaining.

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The electric street cars of St. Paul and Minneapolis are to be operated by water power. Seven generators of the General Electric Company's make, driven by as many Stillwell Bierce turbines of 1,000 horse-power each, are to be installed below the falls, a dam having been constructed for that purpose. Direct current generators will supply the current for Minneapolis; but owing to the increased distance, the St. Paul system will be operated by the three-phase system with the usual arrangement of transformers and rotary converters. One of the three existing steam plants will be dismantled, but the others will be kept for use in emergencies.

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The steamer "Paris," of the "American" Line, has just made an entire eastward trip by the aid of one engine and one screw, the outboard sleeve of the port propeller shaft having been cracked on the last westward trip, entirely disabling that side. The "Paris" made very good time for the run, and although she carried few passengers, she flew the American flag and carried the mails at the usual subsidized rates, and so nobly carried on the purposes of her existence.

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Mr. William Hoge, who is traveling representative of the Gratan & Knight Manufacturing Company, leather belt manufacturers, of Worcester, Mass., was presented with a gold medal by the management of the recent fair held in New York for the benefit of the Commercial Travelers' Home Association, the medal being presented to Mr. Hoge as being the originator and "ablest worker" in behalf of the fair.

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On Thursday evening, January 21st, the employés of the Hendey Machine Company, Torrington, Conn., gave a complimentary concert and ball in the new building which constitutes the latest addition to the plant.

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It is announced that a number of Hartley compressed air motor tricycles are to be put into service in Chicago for collecting and delivering mail matter.

Commercial Review.

NEW YORK, SATURDAY EVENING, JAN. 23D.

The trade prognosticators who have been scanning the stars during four years past for signs of improvement still fail to find anything that looks alarmingly lucky. It almost seemed, in view of some reports on machinery supply market last week, as if, in spite of the dullness in sister industries and contradictions in this one itself, there were indications that things were beginning to mend. And notwithstanding some of the people who "reported progress" experienced, to our knowledge, a flurry of business about this time a year ago, which was transient in its nature; and notwithstanding the deliverances of such oracles as Dun and Brad-

(Continued on page 37.)

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Business Specials.

Transient Advertisements 40 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear wheels, gear cutting. Grant; see page 16.

Bronze pattern cast'gs. H. D. Phelps, Ansonia, Ct.

Forming Lathes. Mer. Mach. Tool Co., Meriden, Ct.

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Engine Castings ½ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.

Just Issued—Catalog No. 8. Mailed free. Clayton Air Compressor Works, 28 Cortlandt st., New York.

Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, New Haven, Ct.

The American Ball-Bearing Co., of Cleveland, have exceptionally good facilities for the manufacture of bicycle cups and cones; tempering, case hardening and grinding are a specialty with them.

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Help Wanted.

Situation and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our **subscription** list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Help Wanted—Good pay for leisure hours. Geo. W. Lord, Philadelphia, Pa.

Wanted—Competent draftsm'n for mach. constr.; must have shop exp. Address Box 48, AM. MACH.

Designer and draftsman, printing presses, folders, printers' special machinery; effective worker open Feb. 1. Box 45, AMERICAN MACHINIST.

Wanted—Pos. by a punch and die maker, large experience, expert tool maker, fair draughtsman. Address Box 35, care AMERICAN MACHINIST.

Draftsman wants position; experienced in steam pump and general machinery; shop and drafting room experience. Box 39, AMERICAN MACHINIST.

A man of experience and thoroughly up to date in manufacturing, wants position as foreman of machine shop or tool room. A 1 reference. Box 49, AMERICAN MACHINIST.

Wanted—The services of a first-class mechanical engineer; one familiar with the constr. and operation of steam hammers preferred. Address, stating salary expected, Box 47, AMERICAN MACHINIST.

A technical graduate, first-class draftsman, practically familiar with the details of machine construction, would like to secure opening with reliable house; references from late employer. A, B and C, P. O. Box 2890, N. Y. City.

Wanted—Pos. as foreman of tool room in bicycle factory; thoroughly up to date in every way; having had 15 years' experience in the bicycle line as workman, foreman and designer; Eastern experience chiefly. Box 37, AMERICAN MACHINIST.

Wanted—By a thorough practical mechanic, tool maker and draftsman, pos. with an English bicycle, scientific instrument or specialty manuf'g concern where auto. and special mach'y is required; 16 yrs. exp.; A 1 ref.; correspd. desired. Box 38, AM. MACH.

Change desired by exp. mach. and tool maker; large exp. as foreman in mfg. type-writers, cash-registers, sewing-mach. and similar work; can produce work accur'tely and econom'y on gear-cutters, presses, milling and sew. mach. Box 46, AM. MACH.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d h'd lathes & planers. S. M. York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co., Springfield, Mass.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

The Dutton Wet Twist Drill-Grinder is sold by the Garvin Machine Co., of Spring and Varick streets, New York City.

We make a specialty of Shartle's patent safety set collars. Prices low and samples free. Middletown Machine Co., Middletown, Ohio.

For Sale—Entire equipment of a jewelry factory, whole or in part; Reed lathe, 12 in. x 5 ft.; also smaller lathe, presses, drop, rolls, gas furnaces, etc. Leward, 95 William st.

We offer an exceedingly fine lot of first-class second-hand machinery, lathes, planers, shapers, drills, millers, screw machines, etc. Call, or get list 17 B. The Garvin Mach. Co., 440 Canal st. N. Y.

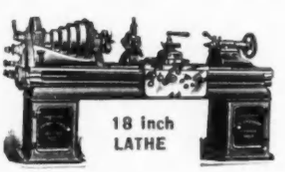
Wanted—An Idea. Who can think of some simple thing to patent? Protect your ideas; they may bring you wealth. Write John Wedderburn & Co., Patent Attorneys, Washington, D. C., for their $1,800 prize offered to inventors.

Columbia University
in the City of New York.

SCHOOL OF MINES,
SCHOOL OF CHEMISTRY,
SCHOOL OF ENGINEERING,
SCHOOL OF ARCHITECTURE,
SCHOOL OF PURE SCIENCE.

Four years' undergraduate courses and special facilities for graduate work in all departments. Circulars forwarded on application to the Secretary of the University.

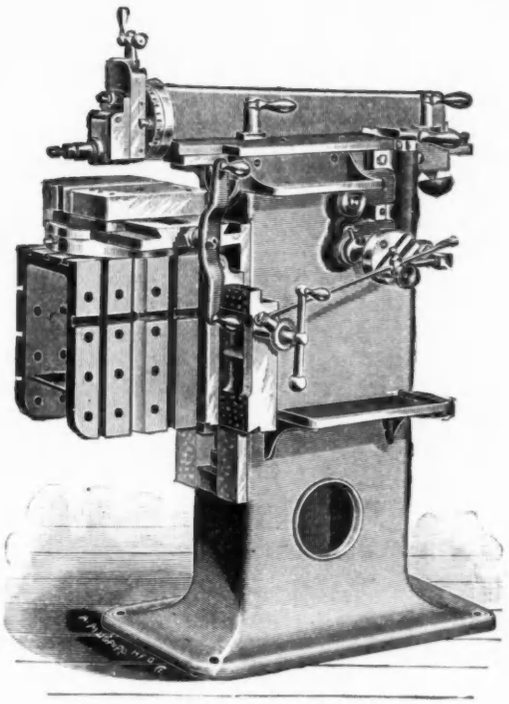
LATHES



FITCHBURG MACHINE WORKS
FITCHBURG, MASS., U. S. A.

METAL-WORKING MACHINERY.

CATALOG E.



..IMPROVED..

15-inch Hendey Shaper.

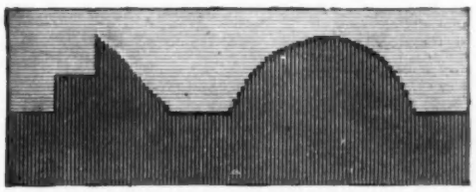
Latest Improvements.
Useful Attachments.
Strong and Powerful.

...FOR...

Die Work, Tool Room or General Shop Work.

▲ ▲ ▲ ▲

The stroke can be adjusted for curves with machine in motion. The stroke can be adjusted for angles with machine in motion. The stroke can be adjusted for irregular work with machine in motion. It has adjustable table for planing taper work; table can be removed for fastening work to apron. Has a strong graduated swivel vise. Quick work, rapid changes, modern ideas.



This cut shows how stroke can be adjusted with machine in motion by micrometer; adjustment fine and delicate. SEND FOR CIRCULAR.

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THE HENDEY MACHINE CO.

TORRINGTON, CONN.

Agents for the Pacific Coast—PACIFIC TOOL AND SUPPLY COMPANY, San Francisco, Cal.

European Agents, { **CHAS. CHURCHILL & CO., London and Birmingham.**
SCHUCHARDT & SCHÜTTE, Berlin and Vienna.
EUGEN SOLLER, Basel, Switzerland.

(Continued from page 36.)

street are now pretty conservative, we are not entirely discouraged now.

The condition of the

IRON WORKING MACHINERY

market, after one has gone through the usual heroic effort necessary to harmonize and average conflicting reports, seems to resolve itself into a state of somewhat better feeling and better inquiry, with sales as yet not noticeably increased.

The railroads have not gotten ready to make purchases. The bicycle people, though buying some, are rather tardy about entering the market for tools this year. They may be holding off to see what one another are going to do. Perhaps after the New York and Chicago bicycle shows have set the pace, a period of more demand from them may set in.

Export trade of machine tools, from what can be gathered from local concerns, is somewhat less active in respect to fresh orders than it has been. There is some relaxation of effort owing to the return of the foreign ambassadors of various houses. It is natural that this, like other kinds of trade, should have its seasons.

Taking things all in all, the market situation is not entirely unfavorable, although the phrase "in the spring," which crops out among some otherwise reassuring words, has a sound not quite as satisfying as might be. The representative of one of the Western companies finds that people are beginning to drop into the store and talk business, which they did not do two or three weeks ago.

WOOD WORKING MACHINERY.

This is a class of merchandise which, all along, has seemed more depressed than iron working machinery. There is but little change now from former conditions and yet some individual reports are decidedly bright.

The Glen Cove Machine Co. say: "The business situation in our line, in common with others, is, we think, improving, although gradually. The outlook is favorable, and in our own business we have had good orders. Indeed the state of our trade is better now than it generally is at this season of the year."

The Berlin Machine Works say from their Eastern branch: "Our business is at present better than we can explain and we shall be satisfied if it continues through the year pro rata as it has done already. The territory covered by this office and from which the orders come includes New York State, New England, Pennsylvania, etc."

EXPORTS OF MACHINERY.

The United States Treasury Department's Monthly Summary of Finance and Commerce for November, 1896, shows: Total value of machinery included among domestic exports for the month, $2,386,903, against $1,677,009 for November, 1895. The figures for October, 1896, were $2,425,-

437, so the maximum for the season evidently was then reached.

Our own summation of distinguishable items of machinery in the cargo manifests of exports from the port of New York which have been reported through the Custom House during the week ending January 23d, gives $390,000.

THE IRON MARKET.

While published reports of the status of the pig iron business are not all alarmingly bullish, we have heard some from participants in the market which afford ground on which to base hope. Messrs. Rogers, Brown & Co., who do a very large business in pig iron, detect a favorable sign in the fact that their sales in Chicago and St. Louis have been larger during the past week than hitherto; because an improvement in the iron market is expected to come from the West. Exports of pig iron continue good, and the reason that their volume is not much greater still is because of the lack of freight room.

The Sterling Steel Company, of Pittsburg, has consolidated with the American crucible steel business of Thomas Firth & Sons, Limited, of Sheffield, England, and for the first time Sheffield steel will be made in this country under the famous process.

An open market has been declared on machine bolts, common carriage bolts and nuts by the associations of their manufacturers, while the discount rates fixed on stove and tire bolts in December will be maintained if possible.

Copper and tin are very bullish, as our quotations show.

Quotations.

NEW YORK, Monday, January 25th.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$12 00 @ $13 00
No. 2 foundry, Northern	11 50 @ 12 00
No. 2 plain, Northern	11 25 @ 11 50
Gray Forge	10 50 @ 11 50
No. 1 foundry, Southern	11 50 @ 12 00
No. 2 foundry, Southern	11 00 @ 11 25
No. 3 foundry, Southern	10 50 @ 11 00
No. 1 soft, Southern	11 00 @ 11 50
No. 2 soft, Southern	10 50 @ 11 00
Foundry forge, or No. 4 Southern	10 25 @ 11 00

Bar Iron—Base—Mill price, in carloads, on dock: common, 1.10 @ 1.15c.; refined, 1.20 @ 1.50c. Store prices: common, 1.40 @ 1.50c.: refined, 1.50 @ 1.80c

Tool Steel—Ordinary sizes, standard quality, 6 @ 7c., with some brands perhaps a little less; extra grades, 11 @ 12c.; special grades, 16c. and upward

Machinery Steel—Ordinary brands, from store, 1.60 @ 1.65c.

Cold Rolled Steel Shafting—Base size, 2¼c. from store.

Copper—Carload lots, Lake Superior ingot, 12.00c.; electrolytic, 11¾c.; casting copper, 11½c.

Pig Tin—For 5 and 10-ton lots, 13.90 @ 14.00c., f. o. b.

Pig Lead—In carload lots, 3.05 @ 3.10c., f. o. b.

Spelter—In carload lots, New York delivery, 3.90c., f. o. b. and upward.

Antimony—Cookson's, 7⅛ @ 7⅛c.; Hallett's, 6⅝ @ 6¾c.

Lard Oil—Prime city, present make, commercial quality, in wholesale lots, 40 @ 42c.

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Manufactures.

H. G. McGhee & Co., Bedford, Va., will install new machinery.

The Ohio Steel Company, Youngstown, O., will erect new furnaces.

C. P. Woodruff, of Williamsville, Mass., intends to build a planing mill.

Messrs. Tolley & Betterton will erect a distillery at Chattanooga, Tenn.

(Continued on page 39.)

The Pratt & Whitney Co. HARTFORD, CONN., U.S.A.

...MAKERS OF...

Fine Machine Tools.

Complete Plants furnished for Bicycle, Typewriter, Gun and Sewing Machine Makers. Gauges and Small Tools for all Machine Work. Drop Hammers and Trimming Presses. Forging and Trimming Dies for all classes of work.

England—BUCK & HICKMAN, 280 Whitechapel Road, London, E.
France—FENWICK FRERES & CO., 21 Rue Martel, Paris.
Germany and Austria—SCHUCHARDT & SCHUTTE, Berlin and Vienna.
Chicago—42 and 44 South Clinton St. *Boston*—281 Franklin St. *New York*—123 Liberty St.

"GREEN RIVER" PATENT SPIRAL FLUTED SHELL REAMERS AND ARBORS IN CASES.

SEND FOR CATALOGUE.

WILEY & RUSSELL MFG. CO., Greenfield, Mass., U.S.A.

Agents in London, SELIG, SONNENTHAL & CO., 85 Queen Victoria Street.

Machinery.

ROBINSON — "Mechanism,"	$3.00
CROMWELL — "Toothed Gearing,"	1.50
CROMWELL — "Belts and Pulleys,"	1.50
MacCORD — "Kinematics,"	5.00

JOHN WILEY & SONS,
53 East Tenth Street, NEW YORK CITY.

CATALOGUE FREE.

SPEAKING OF LATHES! We are building them in various sizes from 9-in. to 15-in. swing, in various lengths, both engine and speed lathes. Our designs are the latest and most approved, while the workmanship, material and finish are of the highest order. Our catalogue will tell you all about them, as well as of our planers, shapers, drills and other tools and supplies.

SEBASTIAN LATHE COMPANY,
117 and 119 CULVERT STREET, CINCINNATI, OHIO.

DYER & DRISCOLL,
PATENT SOLICITORS, 36 WALL ST., N.Y.

Have done all my patent soliciting work, both for this and foreign countries, continously for the past fourteen years.

Thomas A. Edison

STAR LATHES

★ ★ ★

Foot Power Screw Cutting, Automatic Cross Feed, 9 and 12" Swing.

Send for Catalog B.

Seneca Falls Mfg. Co.
687 Water St., Seneca Falls, N.Y.

'96 THE NEW '96 JENKINS '96

IS the Perfection of Joint Packing. Instantaneous, **Does Not Squeeze Out** and not necessary to follow up joint. We guarantee it to last for years on any and all pressures of steam or any kind of joint where packing is required. Does not rot, burn or blow out, therefore the best for all purposes. Call for and insist on having '96 JENKINS '96, stamped like cut. . . . . .

JENKINS BROS., New York, Boston, Phila., Chicago.

NORTON EMERY WHEEL CO.

SEND FOR CATALOGUE

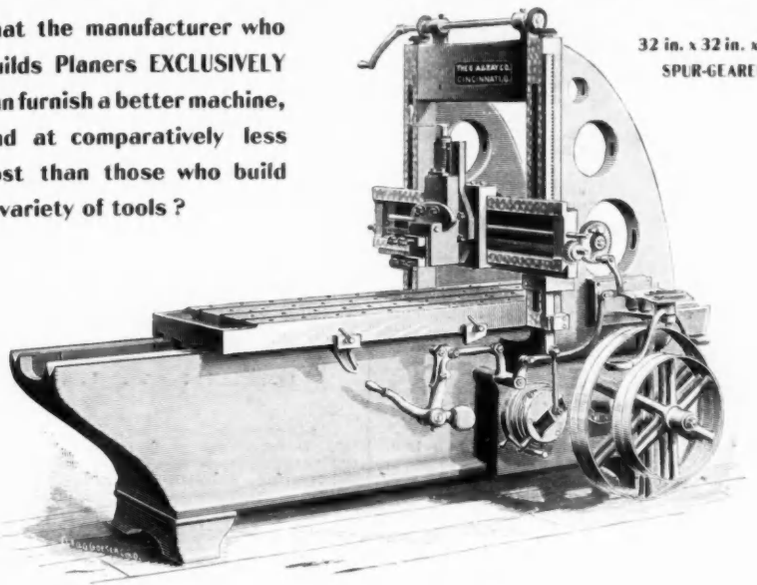
WORCESTER MASS.

Automatic Solid Die Bolt
THREADING MACHINES.
Two Styles. Four Sizes.
Send for Catalogue "A."
Webster & Perks Tool Co.
Cor. Spring and Monroe Sts.,
Springfield, Ohio.

HARVEY HUBBELL
Machinery and Tool Mfr.
Improved Tapping Machines
SCREWS
Machine Screws for electrical purposes.
Sample Box Free.
33-35 Organ St., Bridgeport, Conn.

DON'T YOU THINK

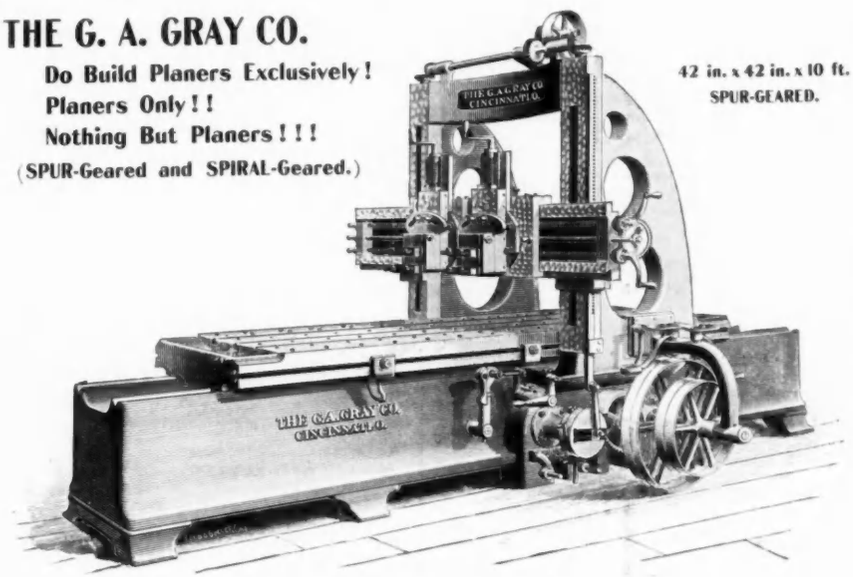
That the manufacturer who builds Planers EXCLUSIVELY can furnish a better machine, and at comparatively less cost than those who build a variety of tools?



32 in. x 32 in. x 6 ft
SPUR-GEARED.

THE G. A. GRAY CO.

Do Build Planers Exclusively!
Planers Only!!
Nothing But Planers!!!
(SPUR-Geared and SPIRAL-Geared.)



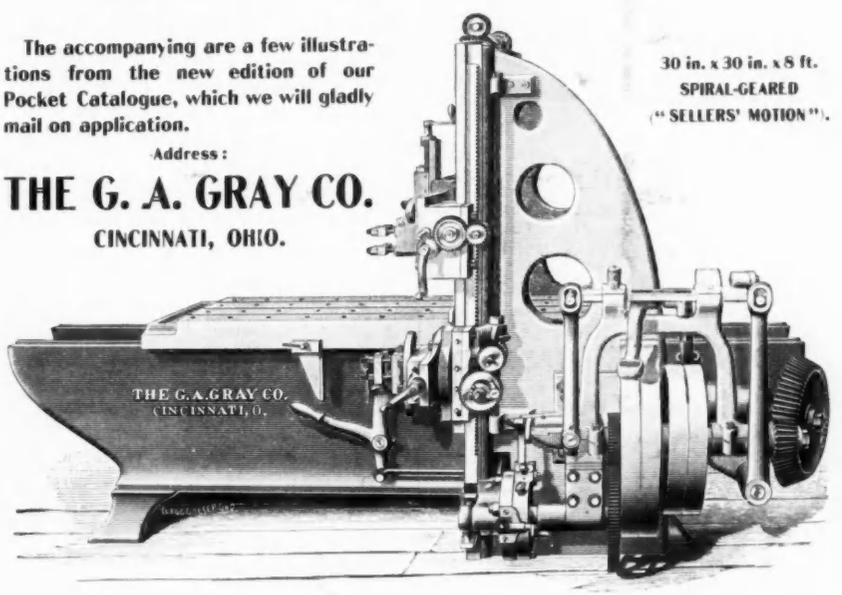
42 in. x 42 in. x 10 ft.
SPUR-GEARED.

The accompanying are a few illustrations from the new edition of our Pocket Catalogue, which we will gladly mail on application.

Address:

THE G. A. GRAY CO.

CINCINNATI, OHIO.



30 in. x 30 in. x 8 ft.
SPIRAL-GEARED
("SELLERS' MOTION").

(Continued from page 38.)

The Emery Wheel Company, Springfield, O., expects to enlarge its plant.

The Hagerstown, Md., Electrical Company will erect a new power house.

James Robinson, of Webster, Mass., is building an addition to his factory.

Mr. John Drake, of Traver, Cal., intends to build a machine shop at Reedley.

Laughlin tin plate works at Martin's Ferry, O., will have a new mill erected.

It is probable that H. O. Havemeyer will erect a new sugar plant at Toledo, O.

The Willimantic Thread Company, Willimantic, Conn., are to instal new boilers.

Messrs. Melvin Earl & David Baum are erecting a grist mill at Gloversville, N. Y.

Hamilton Bros., Pittsburg, Pa., are to erect a new glass factory at Latrobe, Pa.

The Dickson Manufacturing Company, Scranton, Pa., is enlarging its foundry plant.

Wm. C. Wynkoop, of Denver, Colo., is interested in the erection of a mill in Cochiti, Colo.

The Sullivan Foundry & Marine Engine Works at Sing Sing, N. Y., are nearing completion.

The planing mill of Denton & Waterbury, Whitesboro, N. Y., was lately destroyed by fire.

The mill property of Mr. Robert MacKinnon, Little Falls, N. Y., will be enlarged shortly.

The plant of the North Shore Brewing Company, of Berea, O., was recently destroyed by fire.

The Weir Stove Company, Weir Village, Mass., will add another building to its large plant.

The Pennsylvania Oil Company's refinery at Casper, Wyo., will have new machinery put in.

The Merrow Machine Company, Hartford, Conn., will make additions of machinery to their plant.

The Perth Amboy City Water Works, Perth Amboy, N. J., are about to install new pumping engines.

The Ogdensburg Gas Company, Ogdensburg, N. Y., will erect a building for manufacturing purposes.

New machinery will be added to the plant of the Atlanta Textile Manufacturing Company, Atlanta, Ga.

At Snohomish, Wash., to manufacture clutch pulleys, the Automatic Clutch Pulley Company has been formed.

Fire in the foundry of Goodal & Waters, Hamilton street, Philadelphia, Pa., caused damage to the extent of $2,000.

The mills and power houses of the Eureka Slate Company at North Poultney, Vt., were wholly destroyed by fire lately.

The American Chicory Company, of which C. Bevan Oldfield is president, expects to erect a new factory at Omaha, Neb.

The Westlake Construction Company has been incorporated at St. Louis, Mo. Incorporators, W. S. Westlake, O. J. Barwick, etc.

The Central Pump Company, with A. P. Smith, J. C. A. Leppelman and F. J. Kuny as interested parties, has been formed at Chicago, Ill.

The Tuthill Water Wheel Company has been incorporated at San Francisco, Cal. Stephen J. Tuthill, C. S. Booth and others are interested.

The Webster Foundry Sand Company has been formed at Mt. Holly, Pa. Those interested are Jas P. Holmes, Geo. A. Wilbur and others.

At Rochester, N. Y., the Electric Laundry Company has been incorporated. Directors, R. W. Groom, Chas. E. Lewis and Marquis K. Simpson.

At Berwick, Me., the Royal Supply Company has been organized, with Milton D. Farnham, of Somerville, president, and Harry J. Taft, treasurer.

The plant of Bagby & Rivers, Baltimore, Md., was recently destroyed by fire, the damage to the

buildings and machinery amounting to about $45,000.

The Fox Paper Company's plant at Crescentville, O., was recently destroyed by fire. It is estimated that machinery was damaged to the amount of $100,000.

It is reported that the King Self-Measuring Oil Elevator Company will move from Providence, R. I., to Worcester, Mass., and the business will be extended.

The Weber Gas & Gasoline Engine Company, Kansas City, Mo., recently shipped three engines, one to Merida, Yucatan, one to Kaslo, B. C., and the third to Caracas.

The Reese Manufacturing Company, of Irvington, Va., has been formed with a capital of $100,000. Geo. O. Manning, Sr., is president and J. C. Manning is treasurer.

The Burt Labeling Machine Company has been formed at Baltimore, Md. The following gentlemen are interested: Lawrason Riggs, Chas. E. Rieman, Allan McLane, etc.

At Denver, Colo., a company has been formed which will begin the manufacture of (electric) light carbons. The directors are J. F. Saunders, J. T. Hand and J. D. Schoonmaker.

It is expected that ere long the new plant proposed by the Newark Weldless Tube & Steel Company, of which Dr. S. B. Bishop, of Pittsburg, is president, will be commenced.

The Chattanooga Steel Roofing Company, Chattanooga, Tenn., is preparing to build at once a large addition to its plant in South Chattanooga. The cost will be from $3,000 to $4,000.

Alfred Herbert, Ltd., of Coventry, Eng., is opening a showroom at 7 Leonard street, Finsbury, E. C., London, where an extensive stock of tools and machinery will be carried, particularly those of American production.

The Samuel Hunter Company has been formed at Buffalo, N. Y. The manufacture of stair and hand rails, etc., will be engaged in. Samuel Hunter, of Leechburg, Pa., Aryel C. Buell, Frank C. King and others of Buffalo are interested.

The Mack Injector Company, of Boston, Mass., has leased the building owned by the Lynn Gas & Electric Company, Lynn, Mass., and will go into the general machinery business in addition to the manufacture of locomotive injectors.

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New Catalogs.

There are three sizes of Standard Catalogs, first authorized by the Master Car Builders' Association, 9" x 12", 6" x 9" and 3½" x 6". We recommend the 6" x 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

The Waltham Watch Tool Co., Springfield, Mass. have issued a catalog in which is described the Van Norman "Duplex" milling machine, which was illustrated and described in our issue of October 8, 1896. Different views of the machine are given, showing the cutter head in various positions. It is 6 x 9¼ inches.

The Cincinnati Milling Machine Company, Cincinnati, O., have sent us a catalog devoted to the illustration and description of milling machines both plain and universal, and of various sizes. The descriptions of the various parts of the machines are very full and complete. The telegraph code used in ordering these machines is given also, and the catalog is standard size, 6 x 9 inches.

The Risdon Iron Works, San Francisco, Cal., send us catalogs Nos. 5 and 8, the former of which contains illustrations and descriptions of hydraulic elevators and mining machinery, and the latter describes and illustrates various forms of mills, rock-breakers, concentrators and other machinery for grinding and reducing ores. They are both 6¾ x 10¼ inches and contain some very fine half-tone pictures.

The Buffalo Forge Co., Buffalo, N. Y., have sent us a copy of their 400 page 1896 catalog, which is bound in cloth and profusely illustrated with engravings of fans, blowers, exhausters, and heating and ventilating machinery of various kinds, together with half tone pictures of office buildings, mechanical schools, factories, churches, etc., in which this company's system is in use. The catalog is 7¼ x 9 inches.

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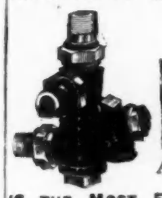

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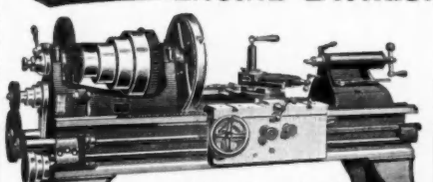

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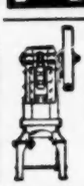

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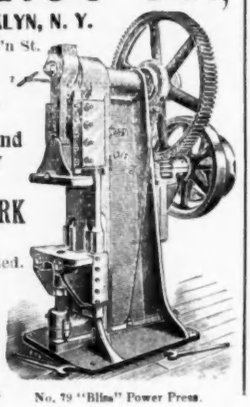
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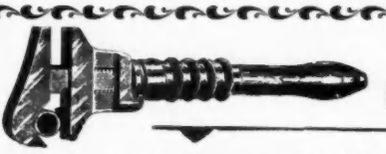

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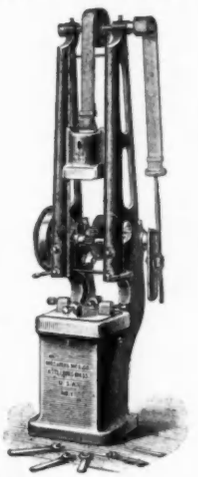

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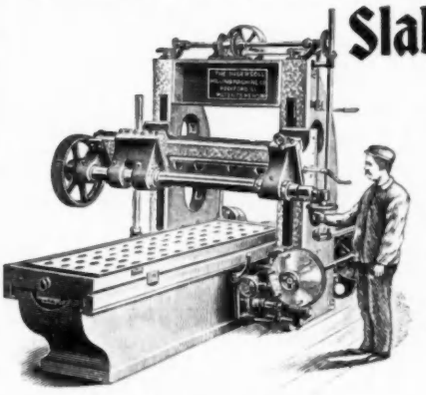

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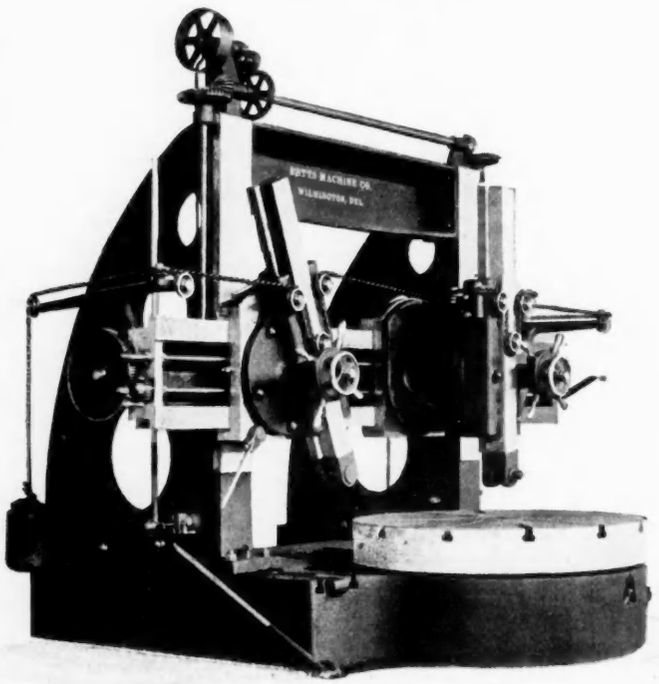

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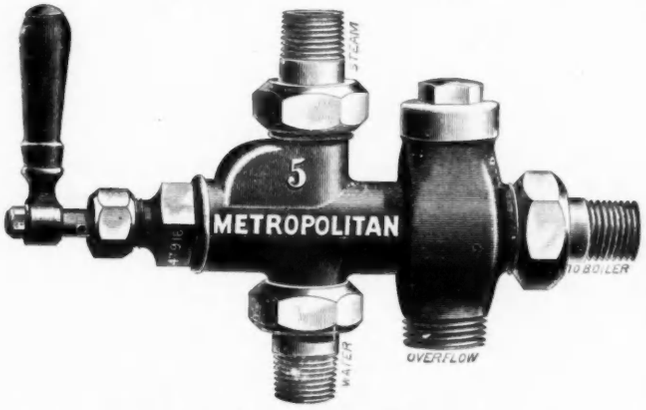

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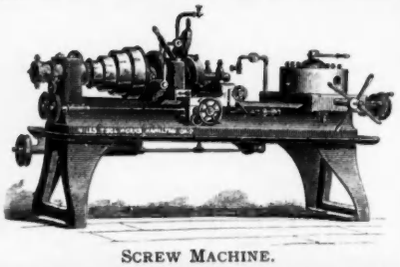

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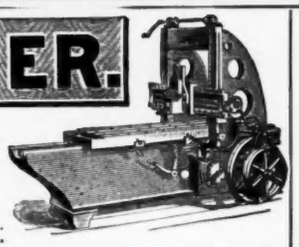

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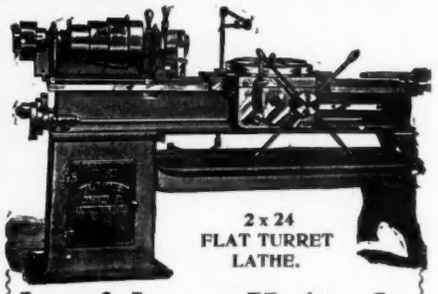

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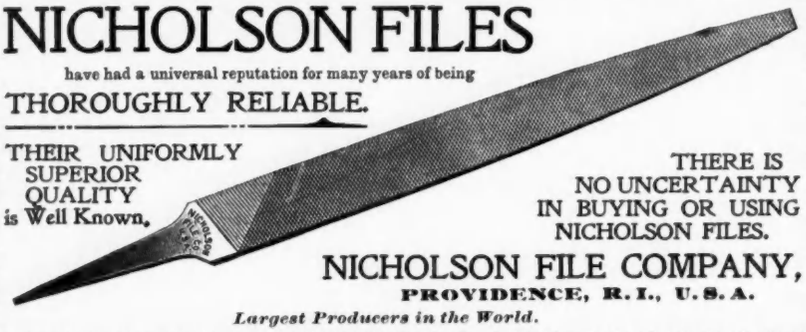

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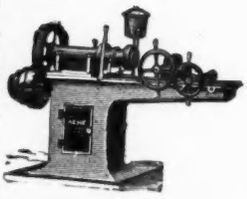

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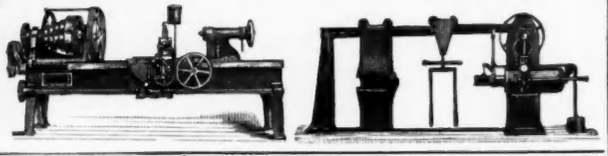

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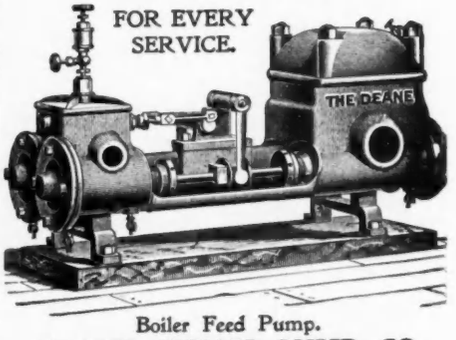

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